A Semi-Monthly Technical Newspaper

Metallurgical & Chemical Engineering

New York, December 15, 1917 McGraw-Hill Publishing Co., Inc. Vol. XVII, No. 12 25c a copy

Metallurgical and Chemical Engineering

A Consolidation of
Electrochemical and Metallurgical Industry and Iron and Steel Magazine

Vol. XVII | NEW YORK, DECEMBER 15, 1917 | No. 12

PUBLISHED SEMI-MONTHLY ON THE FIRST AND FIFTEENTH OF EACH MONTH BY THE
McGRAW-HILL PUBLISHING COMPANY, INC.
JAMES H. McGRAW, President.
J. H. McGRAW, JR., Secretary. ARTHUR J. BALDWIN, Treasurer
Tenth Ave. at 36th St., New York.
TELEPHONE, 2840 GREELEY. CABLE ADDRESS, METCHEM, NEW YORK
ROCKY MOUNTAIN OFFICE..........401 Boston Bldg., Denver, Col.
PACIFIC COAST OFFICE..........Rialto Bldg., San Francisco, Cal.
CHICAGO OFFICE..........Old Colony Building
CLEVELAND OFFICE..........Leader-News Building
PHILADELPHIA OFFICE..........Real Estate Trust Building
LONDON OFFICE..........Hastings House, Norfolk St., Strand

H. C. PARMELEE, Acting Editor.
ERNEST E. THUM, Associate Editor.
R. C. BERGEN, Assistant Editor.

J. MALCOLM MUIR, Manager.

Yearly subscription price for United States, Mexico and United States dependencies, $3.00; *all other countries,* $4.00.
Single Copy 25 Cents

When change of address is ordered, the NEW and the OLD address must be given. Notice must be received at least 10 days before the change takes place. No back copies for more than three months.

Entered as Second-Class Matter at the Post Office at New York, N. Y., under the Act of Congress, March 3, 1879.

Circulation of this issue 11,300 copies

Contents for December 15, 1917

Washington

It did not require the assembling of Congress to direct the nation's interest toward Washington, for in addition to its natural eminence as the political center of this country, the capital has become the industrial center of the world. One who has not visited Washington within the last few months, or who is not in some way closely in touch with affairs there, can have no adequate conception of the extent to which the capital has taken on the atmosphere of industry. Politics, in the ordinary sense, is in the background.

At this session Congress will have to deal with problems of transportation, taxation, labor, price-fixing, water power and the combination of exporters—vital issues in which every citizen is interested.

The Optical Glass Problem

One of the interesting developments in American industry due to war conditions is that a beginning is at last being made in the manufacture of optical glass. As most of our readers know, the general supply of this material heretofore has come from three great firms, one in France, one in Germany, the third in England. At the outbreak of the war practically all the product was commandeered for home use, and exports, rapidly dwindling, very soon stopped. Now that the United States is in the fight, the demand for optical glass for the manufacture of field glasses, range finders and other optical instruments necessary in war has far outrun the limited supply in stock. For a year the necessity for American manufacture has been evident.

At the present time there is good hope that the requirements may be met by home product, inasmuch as two or three large concerns have taken up the manufacture either for their own needs or for the general market. The production of optical glass is one of peculiar technical difficulties, both chemical and mechanical. It is perfectly easy to analyze the various commercial varieties of glass, but the data thus gained do not give full information as to the proportions in which the actual components must be used in the melting. Only considerable experience can give the concrete information necessary for the production of a good glass of predetermined optical properties.

Even when this information is gained, it is a well known fact that consecutive meltings of the same nominal composition may vary materially in refraction and dispersion owing to the different degrees or different ways in which the ingredients, for reasons as yet somewhat imperfectly known, actually combine. Thus in the catalogs of the great foreign optical glass works

large numbers of odd meltings not conforming strictly to type may be found listed. Curiously enough, some of these possess very valuable properties which cannot reliably be reproduced, as, for instance, a particular melting of optical crown which came to this country a few years ago and proved capable of giving an exceptionally good color-correction to the telescope objectives made from it. Again, after all the chemical problems seem to have been mastered there is the difficult mechanical task of securing suitable mixing of the materials, freedom from bubbles and streaks, and in general such physical uniformity of product as makes it possible to get pieces of considerable size and first-rate quality. Certain glasses, very valuable in the manufacture of photographic objectives, have never yet been obtained reasonably free from bubbles, and certain other varieties show an apparently unavoidable tendency to develop striæ which cannot be thoroughly worked out.

It takes courage for a manufacturer to go into this particular line of work with the determination to provide a commercial product on any considerable scale, and the country is to be congratulated on the efforts which have already been made. From one large concern at least it is now possible to get a few fundamental varieties of optical glass and there is good prospect that more are coming. One or two other organizations are working with good measure of success along the same line, but not for purposes of general supply.

The four most necessary varieties of glass, to wit, a very light and transparent crown suitable for field-glass prisms, an ordinary crown of slightly higher index, a typical heavy flint, and a typical light flint, are already in production. The two next in point of importance are a heavy baryta crown and a light baryta flint used particularly in photographic lenses, and these we learn are under way with every prospect of reaching suitable commercial development. The other necessary varieties of these several species will come along in due season, but if a good supply of well annealed material, even of the half-dozen sorts here enumerated, can be had, the country will be in pretty good shape to make its own optical instruments.

The matter of suitable mixing and annealing for the production of discs of large size may be trusted to the future, so long as the outlook for pieces of ordinary dimensions is as good as at present. The primary needs are readily met without going to large discs of the highest possible uniformity. That the problem finally will be solved we may feel reasonably certain from the results already reached, and another will have been added to the list of industries which have come to life in this country during the stress of war. The German optical-glass industry was in a sense the direct outcome of the Franco-Prussian War which inconveniently found France the chief source of supply. We hope to follow up further the developments along this line, which is of great chemical and physical interest besides being important to the prosecution of the war.

Salaries in the Teaching Profession

The president of a large university in the Middle West recently made the following interesting announcement through the press of his city:

"The majority of our instructors and professors who are responding to the call of their country are doing so at salaries greater than those they have been accustomed to receive from this university. This fact speaks volumes for the high character and scientific training possessed by the members of our faculty."

At first glance such a statement is quite sure to impress the reader with admiration for the latent possibilities of the teacher. A second reading will incite respect for a management able to provide such attractive conditions that first-class men will be willing to devote their energies to its activities, even though they might provide for themselves far better elsewhere. But after more deliberate consideration, appears a phase of the question which doubtless did not occur to the author of the statement.

We refer to the disparaging interpretation which a thinking citizen will place upon such an assertion, if he knows the various branches and ranks of the service into which the men are going. They are being commissioned as lieutenants, captains, and occasionally as majors in reserve corps. They have started at the foot of the military ladder, well knowing that there can be no hope of reaching the top, for as soon as the great conflict is over they will be relieved from active service and returned to the reserve. Men from other walks in life, scientists of equal training and experience, are accepting like commissions at enormously reduced salaries. The college instructor, on the contrary, is able to increase his modest stipend in such inferior ranks of the service. Whence, then, is a university able to draw honor and glory to herself from the publication of such a statement as quoted above?

But one might say, as did a recent editorial in *Electrical World*, "The emolument of the college teacher must be appreciably less than that which the same intelligence, energy and enterprise would probably secure in competitive professional or business life, if the teachers are to be leaders in intellectual and scholarly pursuits. If the pay of the college teacher should be recognized to be as great as or greater than that in the outside world of affairs, then the chair of professors will cease to be filled by men who esteem learning and hard intellectual work above everything else in life, and the inspiration of the colleges will cease."

In the field of engineering—and it is from this and allied professions that instructors have gone into the national service—we would utter a word of protest against the selection of teachers by such a criterion. Who, in his student days, failed to absorb inspiration, admiration and determination from a teacher who had attained recognition as a real engineer, and who could go out occasionally to devise metallurgical machinery, or to place some tottering chemical process upon its feet?

In few branches of the world's activities except teaching and the ministry is a man penalized for being in

love with his work—for possessing that prime essential to success. If, as is sometimes charged, the steadily decreasing influence of the church upon the people is due to the steadily lowering qualifications of her representatives, must not the universities of this country take adequate and immediate steps to prevent a similar trend?

Recent addresses by prominent chemists have united in pointing out the danger, not imaginary, but real, of losing our best and most inspiring men from the teaching profession through a lack of reasonable compensation. No matter how thoroughly a man believes that the molding of the young men of this country into straight-thinking citizens is the highest, most worthwhile and enduring labor one is privileged to perform, he may be absolutely forced by low teaching salaries into some other work which has the sole merit of better pay.

The warning is most timely, and deserves reiteration. The exodus of the teachers into industry is a real menace to our civilization; the average mentality of some of our college faculties appears to be decreasing; the disastrous effect upon our coming Americans is self-evident; the continued supply of inspired students is threatened. The adoption by university boards of trustees of the commercial policy of basing continued employment on fitness, coupled with the assurance of a compensation commensurate solely with the ability of the teacher, would work wonders with the efficiency, scholarship and inspiration of our engineering colleges.

Iron and Steel-Producing Capacity

The shortage of coke together with other barriers to full operation of the existing blast furnaces have prevented the output of both pig iron and steel ingots from reaching rates that would disclose the real capacity in this branch of plant equipment. Since about November 1, 1916, actual production has fallen short of the physical capacity. In pig iron there has been an actual decrease in production, while in steel ingots the increase has been less than the additional facilities completed would provide.

Production of pig iron was 19,619,522 tons in the first half of 1916, 19,815,275 tons in the second half of the year and 19,258,235 tons in the first half of this year. The production in the first half of last year represented substantially the available commercial capacity. The pig iron market was on the basis of about $18, and there were a few furnaces idle that could operate at the much higher prices since prevailing for pig iron, provided their raw materials were not correspondingly high. Production in recent months has been at approximately the average rate that obtained in the first half of last year, which means that there has been no increase by reason of idle furnaces being blown in or by reason of a dozen new furnaces that have been completed and blown in from May 13, 1916, up to date. These new furnaces should provide at least 2,000,000 tons of pig iron, and normally inefficient furnaces that ought to be able to operate when iron is high priced should account for several hundred thousand tons more, so that the average rate of production of 39,240,000 tons attained in the first half of last year should now be about 42,000,000 tons, if everything were working well. With the curtailment that began in November of last year on account of coke shortage, with other difficulties, last year's production was only 39,434,797 tons and this year's production promises to fall a shade below that amount.

There has been even more new construction of open-hearth steel furnaces than of blast furnaces. In 1916 there was practically full employment of all existing steel-making facilities, the ingot production of 41,401,917 tons (apart from the 1,371,763 tons of steel castings made) representing approximately the average capacity of the year, a capacity that probably stood at much less than the average at the beginning of the year and at much more at the close of the year. During the present year there have been further additions to capacity, and a summary made in a well informed quarter indicates that there is now in existence capacity sufficient to produce 50,000,000 tons of ingots annually. This is not a totaling of individual works capacities, as stated by their managers, such totals usually proving excessive, but an estimate based upon normal and successful working conditions. In ordinary times a blast furnace capacity of 42,000,000 tons would not support a steel ingot capacity of 50,000,000 tons. The 8,000,000 tons discrepancy, plus the pig iron used in iron and steel foundries, could not be made up by the old material, the industrial scrap, the works scrap and the roll-scale that all go to swell the ingot statistics. As industrial operations are now aligned the discrepancy could probably be made up. Pig iron consumption by iron foundries is unusually low. It is a war of steel, not cast iron. The production of works scrap is unusually high, on account of the liberal cropping required to fill war steel specifications.

The maximum rate of ingot production, 44,000,000 tons, was reached last October, but the estimated output for the current year is only 42,600,000 tons. The new year will be entered with steel ingot capacity 17 per cent in excess of this year's production, 21 per cent in excess of last year's production, and 65 per cent in excess of the production in the best year before the war. There is additional new capacity on the way, but construction work on it is practically suspended in favor of the attempt to operate the existing capacity.

What is needed, more than anything else, for full operation is a better supply of coke for the furnaces that still look to the Connellsville coke region, an assurance of continued full supply of coal for the various by-product oven plants, and a full supply of fuel for the steel works. There has been a decided shortage of Connellsville coke, first developing late in October of last year, an occasional shortage of by-product coal at some of the plants, and a severe shortage of coal at times in some of the steel producing districts, particularly the Youngstown district.

Readers' Views and Comments

The Per Cent of Cracked Gasoline Produced on Basis of Crude Petroleum and Total Gasoline Marketed In 1916 and 1917

To the Editor of Metallurgical & Chemical Engineering

SIR:—The Bureau of Mines has just given out for publication a set of highly important statistics as to the gallonage of the various products of gasoline, kerosene, fuel and lubricating oil, etc., resulting from the distillation of crude oil, marketed in 1916 and the first six months of 1917.

The writer has thought it worth while to calculate the statistics as percentages and to correlate the same with other available data upon the cracking of petroleum and to derive percentages of straight-run and cracked gasoline therefrom. *On the basis of crude petroleum refined,* 2.44 *per cent of gasoline was made by cracking and* 12.2 *per cent, or practically one-eighth of the entire gasoline sold during* 1916 *and* 1917, *was made by cracking processes.*

Table I tabulates the gallonage of gasoline, kerosene, gas, fuel and lubricating oil, and the production of wax, coke, asphalt, and loss occurring during distillation. The data indicate an increase of 16.4 per cent of crude oil refined in the year 1917, over that of 1916, on the assumption that the second half of 1917 will show the same amount of crude oil refined.

TABLE I

PRODUCTION OF PRODUCTS FROM CRUDE PETROLEUM FOR YEAR 1916 AND FIRST SIX MONTHS 1917

	Year Full, 1916	First Six Months, 1917
Crude petroleum distilled, barrels	246,076,266	143,189,374
Gasoline, gal.	2,058,322,838	1,223,379,899
Kerosene, gal.	1,455,495,732	784,411,291
Gas and fuel oil	4,290,423,757	2,697,870,034
Lubricating	624,541,195	350,358,041
Wax (lb.)	386,180,898	203,975,713
Coke (tons)	405,319	229,723
Asphaltum (tons)	715,776	319,043
Miscellaneous (gal.)	200,596,682	129,517,218
Loss in barrels	10,008,517	5,208,283

In Table II the percentage yields of distillation products for the seven sections of the United States are compared for the year 1916 and the first six months of 1917. It is interesting to compare, for example, the actual percentage yields of gasoline of the various sections of the country. There are some errors in the original data due to the incorrectness of the returns to the Bureau of Mines, but nevertheless they are good approximations. In all the fields, with the exception of the Mid-Continent (Oklahoma and Kansas), the percentage yield of gasoline increased in 1917. The average for the whole country showed a 0.4 per cent increase of gasoline on the basis of crude petroleum distilled. This increase cannot be ascribed to increased yield due to cracking of petroleum distillates, but in all likelihood is due mainly to cutting deeper into the kerosene cut in distillation of the crude oil. For it is well known that the percentages of gasoline are decreasing in the crude based upon old standards of end-point distillation. It is also well known that the end point of distillation of gasoline two years or more ago was around 300° F., whereas the end point at the present time runs around 400° F., with a strong tendency in some parts of the country to go to 500° F. The increase of the end point of gasoline allows of the use of more naphtha and kerosene as motor fuel for internal combustion engines but there is a limit to the use of higher-boiling-point cuts from crude oil with the present design of motors in automobiles, unless some radical changes are made in the design so that the higher-boiling-point distillates may be available as motor fuel.

TABLE II

PER CENT OF PRODUCTS FROM CRUDE POTROLEUM IN SEVEN SECTIONS OF THE UNITED STATES

Full Year 1916 and First Six Months 1917

Total Barrels Crude Petroleum Refined, 246,076,266 for Year 1916.

Total Barrels Crude Petroleum Refined, 143,189,374 for First Six Months 1917.

	W. Ohio, Ill., Ky., Tenn.		Okla., Kan.*		Col., Wyo.*		W. Va., N. Y., Pa., E. Ohio	
	Full Year 1916 Per Cent	6 Mo. Year 1917 Per Cent	Full Year 1916 Per Cent	6 Mo. Year 1917 Per Cent	Full Year 1916 Per Cent	6 Mo. Year 1917 Per Cent	Full Year 1916 Per Cent	6 Mo. Year 1917 Per Cent
Gasoline	34.0	36.0	32.5	27.0	32.0	37.0	21.0	24.6
Kerosene	14.6	14.0	19.4	14.5	16.4	17.0	27.0	21.0
Gas and fuel oil	26.0	25.0	54.0	49.0	53.4	52.0	18.0	23.0
Lubricating oil	8.8	8.9	1.2	1.5	0.7	0.5	23.0	23.0
Wax	1.0	6.3	....	0.5	....	0.7	....	3.0
Coke	3.0	1.1	....	0.5	....	....	....	0.7
Asphalt	0.7	3.1	....	3.5	....	....	....	0.3
Miscel. oil	6.0	0.8	0.9	0.7	0.1	....	2.9	0.08
Loss	5.4	4.8	4.3	2.8	4.0	9.0	10.0	4.4

	East Coast		Texas, La.		Cal.		Average for U. S.	
	Full Year 1916 Per Cent	6 Mo. Year 1917 Per Cent	Full Year 1916 Per Cent	6 Mo. Year 1917 Per Cent	Full Year 1916 Per Cent	6 Mo. Year 1917 Per Cent	Full Year 1916 Per Cent	6 Mo. Year 1917 Per Cent
Gasoline	20.7	22.0	11.0	12.0	11.0	11.0	19.9	20.3
Kerosene	22.4	22.0	9.0	11.0	4.8	4.0	14.0	13.0
Gas and fuel oil	30.0	29.0	25.0	45.0	67.0	62.0	41.5	44.0
Lubricating oil	12.6	11.0	23.6	2.7	1.5	3.0	6.0	5.8
Wax	1.0	2.0	0.7	1.0	....	2.6	1.9	2.1
Coke	2.4	1.2	2.2	1.7	....	....	1.9	1.8
Asphalt	2.4	3.0	22.7	3.3	12.0	....	3.9	4.1
Miscel. oil	2.0	2.8	0.6	20.6	2.0	....	6.9	5.6
Loss	6.3	7.0	2.0	2.7	1.6	1.4	4.0	3.6

*Values are in error; total per cent products add above 100.

CRACKED GASOLINE.

In the production of gasoline the following table is an approximation of the barrelage of cracked gasoline over the past five years.

TABLE III

CRACKED GASOLINE MARKETED OVER FIVE-YEAR PERIOD

Year	Barrels
1913	1,000,000
1914	3,000,000
1915	4,000,000
1916	6,000,000
1917	7,000,000

From Tables I and III the following percentage yield in Table IV of straight-run and cracked gasoline is shown upon the basis of total crude oil distilled.

TABLE IV

PER CENT OF STRAIGHT RUN AND CRACKED GASOLINE ON BASIS OF TOTAL CRUDE PETROLEUM REFINED

	Full Year 1916 Per Cent	First Six Months 1917 Per Cent
Straight-run gasoline	17.47	17.89
Cracked gasoline	2.43	2.44

During the last two years, of all the gasoline sold 12 per cent, or, roughly, one-eighth, was cracked gasoline. Table V tabulates the percentages of straight-run and cracked gasoline.

TABLE V
PER CENT OF STRAIGHT-RUN GASOLINE AND CRACKED GASOLINE ON BASIS OF TOTAL GASOLINE MARKETED

	Full Year 1916 Per Cent	First Six Months 1917 Per Cent
Straight-run gasoline	87.76	87.98
Cracked gasoline	12.24	12.02

From Table II it is clear that by combining the per cents of kerosene, gas and fuel oil we will have a maximum of 57 per cent of available oil for cracking purposes. It is certain that all of the 57 per cent of combined kerosene, gas and fuel oil is not suitable for conversion to gasoline. In other words, all types of oils will *not* produce gasoline economically, due to high carbon formation. Furthermore, it is well within the facts to state that not more than 60 per cent as an average of marketable gasoline can be made as a *commercial proposition* from the cracking of the 57 per cent of available kerosene, gas and fuel oil resulting from the crude oil. But is it advisable to calculate upon cracking all of the 57 per cent of kerosene, gas and fuel oil into gasoline? Would it not leave a tremendous shortage in fuel oil for industrial uses and our navy? Would it not leave a tremendous shortage in gas manufactured for lighting and heating?

To convert our kerosene, gas and fuel oil into gasoline would also cut down our toluol supply, by at least a million gallons, or a loss of 14,000,000 lb. of our most important explosive, trinitrotoluol. Is the solution of increased quantities of motor fuel a question solely of cracking petroleum oil? Or is it a question in part of radical motor design changes or motor fuel such as alcohol? Or may it be necessary to curtail all motor-car movements to war purposes only? Are we awake *nationally* to the exigencies of the motor-fuel need in our present war? GUSTAV EGLOFF.

Independence, Kan.

Solidifying Points of Naphthalene

To the Editor of Metallurgical & Chemical Engineering

SIR:—We have taken notice of a letter written by F. H. B., published in your journal on Nov. 15, page 570, on solidifying points of naphthalene balls and flake.

We would take this opportunity of emphasizing that the solidifying point of refined naphthalene in between the ranges of 79 deg. C. and 80 deg. C., or a few decimal points above, is not always a true indication of purity of the material, as extensive investigations in our laboratories and abroad have conclusively proved. The solidifying point is really of as little indication or proof as to the positive absence of phenoloids, etc., as the acid test, since the very purest of methylnaphthalenes which has been refined from flue-gas tars has invariably a lower solidifying point than middle and heavy-oil naphthalene, although the first running of even a heavy-oil naphthalene contains frequently an appreciable percentage of methylnaphthalene. Naphthalene refined from this kind of tar (flue-gas tar) will also, no matter how carefully purified, and regardless of its pure white appearance, show a characteristic acid test, singular in its shade and darkness, while a test on phenols and cresols by means of any of the well-known methods would show no trace of these constituents.

We agree with the correspondent that the naphthalene used for the manufacture of naphthalene tablets or balls, etc., ought to be chemically pure, but we maintain that the solidifying point alone is no absolute proof of purity, nor is the acid test, for that matter. As for the naphthalene used for naphthols and amines, etc., as intermediates for dyestuffs, it is indeed very important that more stress should be laid by the refiner upon furnishing the dye manufacturer a purer material. Solidifying point alone will not prove this. Experiments carried on in our laboratories for several months past have conclusively demonstrated that the failure of some of the dyestuff manufacturers to produce some of the dyestuffs at commercially successful yields, and of less brilliancy and fastness, is not due to lack of knowledge and experience alone, but especially in the case of naphthol and amine dyes, largely due to the impurity of the bases, especially the naphthalene itself. A naphthalene of 79 deg. C. solidifying point may be all right for chlorination, sulphonation or nitration, and again it may not. We have had naphthalene under our observation, two samples of the same solidifying point and nearly the same acid test, but refined from two different tars, which gave entirely different yields on sulphonation and also different yields upon conversion into beta naphthol. The danger of a likely unsuitability of a naphathalene for the manufacture of intermediates is, however, largely removed if the naphthalene shows a solidifying point of 79.8 to 80.3. It is not very likely that there is any methylnaphthalene or foreign constituents present.

In cases where the naphthalene from water-gas tar is refined, special care must be taken, of course, to remove all traces of aliphatic hydrocarbons. These are very complex bodies and very stable toward acids and alkalies. Sulphuric acid, for instance, will attack these hydrocarbons to a certain extent, but a small but determinable amount will remain behind closely attached to the naphthalene, and almost colorless. On subliming such naphthalene a pure white brittle flake will be obtained of acceptable solidifying point and fair acid test, but so far it has been found impossible to produce any product of a solidifying point exceeding 79.3 deg. C. This material gives very unsatisfactory results on nitration and halogenation, offering considerable difficulties in purification, and losses due to bad yields.

G. V. HEYL.

Control Laboratories, F. J. Lewis Mfg. Co., Chicago, Ill.

Determination of Phosphorus in High-Speed Steel

To the Editor of Metallurgical & Chemical Engineering

SIR:—In the December 1, 1917, issue of your publition, appears a letter bearing the signature of W. T. Sheffield, containing implications relative to the origin and to the manner of presentation of a method for the determination of phosphorus in high-speed steels, submitted by the writer for the February 1, 1917, issue of METALLURGICAL & CHEMICAL ENGINEERING.

With respect to the originality of the method, I must admit that Mr. Sheffield's experiments considerably antedate those of the writer; with the assumption that Mr. Sheffield's date is correctly given. However, I wish to emphasize that my data were procured and my experimental work was carried out under the impression that no other similar work had been completed by any other chemist. In ascertaining the possibility of the writer's work being anticipated, many compilations of procedures for phosphorus determination in high-

speed steels were consulted and in none was the *modus operandi* the same as contemplated by the writer, especially in regard to the omission of baking in the elimination of tungsten. Furthermore, in a conversation last summer with the chief chemist of Sanderson Brothers Works at Syracuse, N. Y., the modification was discussed and no reference was made by him of a previous origin; which fact occurs to the writer as unusual in view of Mr. Sheffield's statement that his experiments were completed at the Sanderson Works.

Concerning the presentation of the writer's article in the Feb. 1, 1917, issue, it must be remarked that details of washing, filtering, etc., were omitted on the assumption that these would be supplied by the individual analyst, according to his own idea of analytical technique. In Mr. Sheffield's letter a slight inconsistency appears, occasioned by his deduction that "a brief account of the circumstances leading to the development of this modification will enable competent chemists to utilize the method as given by Mr. Kraus with perhaps a little more rapidity, accuracy and intelligence." The procedures of both Mr. Sheffield and the writer are practically the same and are outlined similarly by each.

Finally, the writer wishes it understood that he is far from detracting from the laurels of others and accords the proper credit due the Bureau of Standards men for their research in the use of sulphurous acid in phosphorus determination. EDWARD C. KRAUS.

Dunkirk, N. Y.

Natural Gas and Other Resources of the South

To the Editor of Metallurgical & Chemical Engineering

SIR:—In view of the shortage in fuel supply and the great demand for large supplies of cheap fuel for the manufacture of chemical and other products necessary for the war and agricultural purposes, I am bringing to your attention our unusual supply of natural gas at Shreveport, which is available to large industrial consumers on a basis that makes it cheaper than water power or that derived from the use of coal.

There is now available at Shreveport about 1,000,000,000 cu. ft. of gas daily, and on the basis of scientific estimate the content of the Shreveport field is 2,000,000,000,000 cu. ft., and a very small amount of this gas is now being utilized. This estimate includes only the field as already defined, and does not consider other fields which are being opened up nearby in drilling for oil. A prominent geologist has recently stated that the Shreveport field has the largest supply of natural gas to be found in the United States.

In addition to our gas supply, we have an abundance of raw materials that are needed for war industries at this time. There is close at hand an abundance of iron, petroleum, lignite, limestone, sulphur, and salt, and generous supplies of asphalt, gypsum, kaolin, sand, gravel, clay, etc. It ought to be especially noted at this time that Louisiana has the largest deposits of sulphur and salt to be found in the United States.

Shreveport, La. ELLIS SMITH.

Petroleum Production in California decreased nearly a million barrels in quantity in 1916 as compared with 1915, but the prices per barrel for all grades were raised so materially that the net result was an increase of $13,917,497 in total value.

The Western Metallurgical Field

American Smelting & Refining Company's Smoke Investigations

Following four years' intensive research carried out by a staff of scientists and investigators, under the direction of Dr. P. J. O'Gara, the American Smelting & Refining Company has four very high chimneys either under construction or recently completed; viz: at El Paso, Tex., 30 ft. internal diameter at the top and 400 ft. high; at Helena, Mont., 16 ft. by 400 ft., recently finished; at Tacoma, Wash., 25 ft. by 571 ft., to be finished by Jan. 1, 1918, and at Murray, Utah, 20 ft. by 450 ft., which is 30 per cent completed. The Tacoma stack when completed will be the highest in the world.

The decision to construct these stacks and their auxiliaries, e. g., flues, precipitating plants, etc., has resulted from a scientific demonstration that it is essential to discharge sulphur dioxide at as high temperature as is metallurgically possible and from as high stacks as practicable if damage to surrounding vegetation is to be avoided. Evidently the first step in such a demonstration involves the determination of the real culprit responsible for "smoke damage" to vegetation. Through an extensive series of experiments in growing plants, subjecting them to fumigations of various kinds, degrees and times, following improved methods based on those used by the Selby Smoke Commission, it was determined that sulphur dioxide alone was responsible for injury produced by so-called smelter smoke. In other words, it was shown conclusively that the visible elements of the smoke, such as flue dust and sulphuric acid mist (SO_3), had no part in producing the well-known bleaching on various types of vegetable life, so that taking the color out of the smoke, by any process whatsoever, had no effect upon lessening the danger of possible injury to vegetation. Out of this series of tests one of the most important was that which fully disproved the so-called "invisible damage theory." It was shown that actual bleaching by sulphur dioxide gas was necessary before any decrease in yield of crops was demonstrable. Various crops, including cereal, forage and root crops, were fumigated daily from the time the seedlings appeared above the ground to the day of harvest, with concentrations just below the point of visibly marking or bleaching the plants. This treatment not only did not injure these crops but actually benefited them in producing an increased yield and an increased protein content.

Susceptibility of Crops to Sulphur Dioxide

An extensive series of tests also was made in order to determine the relative susceptibility to sulphur dioxide of a large number of agricultural crops. Naturally, the important thing to know for any district is what crop or crops are most susceptible to injury by SO_2, because in any event the most resistant crops will take care of themselves if smelter operations are such as to prevent injury to the least resistant crops. For some of the least resistant crops, such as barley, oats and alfalfa, it was shown that with high relative humidity of the atmosphere (above 70 per cent), temperature above 40° F., and light values (inter-mountain districts) above 2 per cent of the maximum (this maximum being determined for clear skies with the noon sun at its greatest northern declination) one part per million by

volume (standard conditions) of sulphur dioxide will produce the first slight signs of visible markings if applied for a period of 3 hours. It was also demonstrated that the effect was of the same order if the fumigation was continuous or consisted of a series of puffs of various sulphur dioxide content averaging the former condition. If the time element is increased, all other factors remaining the same, the concentration of SO_2 necessary to produce the same degree of injury must be less; if the time element is shortened the SO_2 concentration must be greater.

At the same time thousands of determinations were made of sulphur dioxide content of the atmosphere at various distances to the lee of the smelters, all readings being accurate to one part in 10 millions of air by volume. Simultaneous readings of stack temperatures and volumes were made and in addition analysis of flue gases. From these data concentration-distance curves were plotted which demonstrated, among many other things, first, that the distance from the stack of the highest sulphur dioxide concentration was greater for higher stacks and hotter gases; second, that the maximum sulphur dioxide concentration varied directly as the amount of sulphur eliminated and inversely as the height of the chimney and the temperature of the gases. Putting it in another way, for low stacks the highest concentration of sulphur dioxide in the smoke stream is nearer the stack than it is in the case of high stacks, with temperatures, volumes and sulphur dioxide concentrations remaining the same. However, the highest concentration or point of maximum for the high stack is lower in proportion to the height of the stack. If the higher stack were twice as high as the low stack then we would expect the point of maximum concentration in the smoke stream to be at twice the distance that it is in the low stack and to have a maximum concentration of sulphur dioxide of only one-fourth that of the low stack.

Limit of SO_2 Concentration in Smoke Stream

Theoretically, therefore, if a smelter operation requires the elimination of a given number of tons of sulphur a day it should be possible to predict a stack height and temperature which will produce a concentration-distance curve having a limiting maximum SO_2 content so that no injury could result therefrom. It has been found that the safe limit of average concentration in the smoke stream must not be more than 3/10 of a part per million of sulphur dioxide in order that the region may be safe from visible markings on the most susceptible vegetation. The reason for stating that an average of 3/10 part per million should be the limiting concentration is based upon the findings that when an average of 3/10 of a part per million was found in a smoke stream, under certain conditions the maximum hourly concentration reached three times that amount, or a little less than one part per million. Failing a stack which will meet the above conditions, close watch on the sulphur dioxide elimination must be kept on days of prevalent winds when the relative atmospheric humidity is high and when the temperature is above 40° F., so that injury to surrounding vegetation may not result because of high sulphur dioxide content of the smoke stream. Injuries due to sulphur dioxide from smelter stacks do not occur generally, but under conditions named above when there is a coincidence of the factors of temperature, light, high relative humidity and wind constancy or prevalency. When such coincidences do occur and it is known that the sulphur dioxide content of the smoke stream is sufficiently high to produce damage, shutting down some of the furnaces is the only alternative if injury is to be averted. This "weather eye" smelter-management is evidently easier in a lead smelter than in a copper plant, for the ordinary Dwight and Lloyd roasters are easily started and stopped, and the sinter may be made during the night in sufficient extra quantity for operating the blast furnaces through the day—the calcine being charged cold as usual. This night operation of the roasters, even greatly in excess of the day operation, is suggested because plants are known to be more resistant during the hours of darkness. In general, most field crops are from 5 to 6 times as resistant at night as they are in the daytime, all other factors remaining the same.

Electric Precipitation of Solids

Since hot smelter smoke rises higher and diffuses so much more readily than colder smoke the Cottrell process is supplanting the baghouse for clarifying the gases from solids. Baghouse operation depends upon relatively low temperatures, 200° F. or thereabouts. Hence in general a great deal of potential energy (heat) must be taken out of the roaster gases if they are to be sent more or less directly through the baghouse—loss of potential energy (heat) simply means that the height to which such cooled gases will rise will be proportionate to the amount of heat remaining in them. The Cottrell process of clearance permits much higher gas temperatures, thus supplanting the baghouse, but the heat thus gained may be insufficient to provide proper diffusion of the huge quantities of sulphur liberated by the larger smelters, even with stacks approaching the constructional limit in bulk, height and expense. In such cases the large plant must either break up into small, isolated units or else install methods for the elimination of excess sulphur from the "smoke stream"—a sulphuric acid plant, as at Garfield, Utah; a liquid sulphur dioxide plant, as at Tacoma, Wash.; or a thiogen or other proposed process which may prove practicable. In any event, the maximum safe elimination of sulphur as sulphur dioxide should be determined and in no case should this maximum be exceeded where injury to vegetation is to be reckoned with. The maximum amount of sulphur that may be eliminated will naturally depend upon local conditions, such as the climatological factors and topography as well as upon the temperature of the gases and the stack height.

Perkin Medal Award

The Perkin Medal Committee, consisting of members of the various chemical societies, has awarded the Perkin Medal for 1918 to Auguste J. Rossi of Niagara Falls, New York, in recognition of his work on titanium. The Perkin Medal was founded in 1906 by the New York Section of the Society of Chemical Industry to commemorate Sir William Perkin, the inventor of mauve. The meeting of the New York Section of the Society of Chemical Industry at which the presentation will take place will be held on Jan. 18 at the Chemists' Club in New York.

St. Louis Meeting of American Institute of Chemical Engineers

The tenth annual meeting of the American Institute of Chemical Engineers was held in St. Louis Dec. 5 to 8. Headquarters were at Hotel Statler. As the local section of the American Chemical Society participated in the meeting throughout, the chairman of the section, Mr. A. C. Boylston, assisted President G. W. Thompson in conducting the sessions of the meeting.

The address of welcome to St. Louis at the opening session was delivered by Mr. Wm. T. Findly, representing Honorable Henry W. Kiel, Mayor of St. Louis. President Thompson responded to the address of welcome. The following officers were elected: G. W. Thompson, president; J. C. Olsen, secretary; F. W. Frerichs, treasurer; M. Toch, auditor; A. W. Smith, T. B. Wagner and D. Wesson, directors.

The secretary reported the membership of the institute as 283, consisting of one honorary member, 241 active and forty-one junior members, an increase of twenty-eight active and five junior members during the past year.

The first paper on the program at the opening session was on "The Relation between Efficiency of Refrigerating Plants and the Purity of Their Ammonia Charge," by Dr. F. W. Frerichs of St. Louis. In a preliminary statement Dr. Frerichs stated that a large amount of ammonium nitrate is required for the manufacture of explosives and that most of the ammonia obtained from the by-product coke oven plants is in the form of ammonium sulphate.

There is only one plant in the United States, namely that of Herf & Frerichs in St. Louis, in which aqua ammonia can be made from ammonium sulphate, and this plant is engaged in producing liquid ammonia for the refrigerating industry. Upon request of the Food Administration of the United States, the capacity of this plant is being increased 50 per cent in order to secure an ample supply of liquid ammonia for the cold storage warehouses and the ice plants so as to conserve the food supply.

In order to obtain an adequate supply of aqua ammonia for the manufacture of ammonium nitrate for the manufacture of explosives, Dr. Frerichs had been requested by the United States Government to erect eight new plants the size of the St. Louis plant at various points. Dr. Frerichs had generously offered the government complete plans and specifications and the use of his patents for the duration of the war, the plants to be dismantled at the close of the war. Publication of Dr. Frerichs' paper is reserved for a later issue.

A paper by Wm. M. Booth of Syracuse, N. Y., on "Distilled Water" was then read.

Wednesday afternoon members of the institute and members of the St. Louis section of the American Chemical Society proceeded by automobile to the very large ice plant of the Anheuser Busch Brewing Association. This plant has a capacity of 1200 tons of ice per day and is the largest plant of its kind in the world.

The party then proceeded to the plant of the Herf & Frerichs Chemical Works. Construction work was here going on both on the extension of the ammonium sulphate plant and on a new plant designed to use ammonia liquors from gas works.

The party then visited the by-product coking plant of the Laclede Gas Light Company.

On Wednesday evening the members of the institute and members of the local section of the American Chemical Society took dinner at the St. Louis Club as the guests of Dr. F. W. Frerichs. The very handsome clubhouse was very much admired. The dinner was held in the spacious dining room on the second floor, which was beautifully decorated with flags. Covers were spread for about eighty.

Thursday morning the party proceeded by automobile from Hotel Statler to the city water works. Mr. E. E. Wall, Water Commissioner of the City of St. Louis, explained the history of the development of water purification in St. Louis and gave an outline of the process employed for purifying water.

The party then proceeded to the Riverside Club, where luncheon was served in the spacious and beautifully decorated dancing pavilion of the club.

After luncheon the party was taken by automobile to Granite City where the plant of the National Enameling & Stamping Company was visited.

On Thursday evening a joint meeting with the local section was held at Hotel Statler. A paper by Gaston Du Bois of the local section on "Engineering and Chemical Works" was first read.

A paper on "Organization of Chemical Companies" was read by Mr. Frank Hemingway.

On Friday morning the members and their guests left the Hotel Statler by automobile for the plant of the Commercial Acid Company.

Some of the members then visited the plant of the Laclede Christy Fire Clay Company.

During the forenoon, three papers were read on the general subject of evaporation and drying. Mr. Hugh K. Moore of Berlin Mills, N. H., read the first paper on "Some General Aspects of Evaporation and Drying."

Mr. F. M. de Beers read the paper on "Some Problems in Evaporation and Drying," presented by Mr. P. B. Sadtler and F. M. de Beers.

Mr. H. McCormack of Chicago read a paper on "Evaporation and Drying of Tannin Extracts by the Carden Process."

On Friday evening the subscription dinner was held at Hotel Statler. The attendance of sixty-three was about equally divided between members of the institute and members of the American Chemical Society.

President Thompson acted as toastmaster and the speakers were Alexander S. Landsdorf, Professor of Electrical Engineering and Dean of the School of Engineering of Washington University; Dr. B. M. Duggar of Shaws Garden, Secretary Olsen and Dr. Charles E. Caspari.

On Saturday the plant of the National Lead Company at Collinsville, Mo., was visited, the mechanical furnace being of special interest to those who made the trip. A private parlor car had been provided for the trip. A special program had been arranged by the local Ladies' Committee under the chairmanship of Mrs. A. A. L. Veillon for the entertainment of the visiting ladies. The St. Louis members proved to be very royal hosts, and the members of the institute were interested to find so many important chemical industries in this locality.

Faraday Society Symposium on Pyrometers and Pyrometry

At a meeting of the Faraday Society held in London Nov. 7, 1917, the general subject of pyrometers and pyrometry was considered in its relation to metallurgy. In addition to the program, which we abstract below, there was an exhibit of instruments by United States and British manufacturers. The first paper presented dealt with the

Production of High Temperature and Its Measurement

BY E. F. NORTHRUP

The author first shows that the refractory properties of carbon offer means of attaining high temperatures, the upper limit of which is the vaporization temperature of that element. Carbon, however, offers an incomplete solution of the problem of attaining high temperatures for heat-treatment of materials, due to the fact that at the temperatures exceeding that obtainable in a platinum-wound furnace, carbon enters into chemical combination with a large number of elements and reduces many chemical compounds.

The difficult and highly important problem for solution is the attainment of chemical purity at very high temperatures.

Another consideration to be touched upon here is that of the inherent thermal inefficiency of every type of resistor furnace when used for producing fusion of a product which melts at a high temperature. The character of the results obtained becomes at once apparent if we consider a special case. Assume we wish to melt with efficiency a nichrome-wound furnace a given mass of copper. The copper would be contained in a graphite crucible, which would be placed in a Norton alundum tube wound on the outside with nichrome wire. Outside the wire-wound tube there would be a cylinder of the best obtainable heat-insulating material with a radial thickness of several centimeters. With this arrangement the heat generated in the wire must travel to reach the copper through, say, 0.5 cm. of heat-insulating material and to reach the outer wall of the furnace through, say, 10 cm. of heat-insulating material. Assume, when the current is first turned on, that the nichrome wire quickly attains its maximum safe temperature of, say, 1282 deg. C., and that at this first moment the copper and the outer wall of the furnace are both at 0 deg C. The temperature gradient, from wire to copper and from wire to outer furnace wall will now be the same. But since the insulation thickness which must be passed through for heat to reach the copper is but one-twentieth that which it must pass through to reach the outer furnace wall, heat will flow approximately twenty times as fast into the copper as it does toward the outer wall of the furnace. By this rapid inflow of heat into the copper the metal will soon be brought, though at a slower and slower rate, to its fusion temperature of 1082 deg. C. But at this stage the temperature gradient from wire to copper has become reduced to 1282 — 1082 = 200 deg. C., while from the wire to the outer furnace wall the gradient remains, as at the beginning, 1282 deg. C. It follows that the ratio of the inflow to the outflow of heat is now greatly diminished, and that the heat which must be given to the copper to furnish its latent heat of fusion to melt it is but slowly supplied under a gradient of only 200 deg. Thus the heat available for fusion may become but a small fraction of the total heat generated in the furnace winding. The efficiency of the furnace as a *melting* furnace is, therefore, low, and if the furnace charge consists of a metal which fuses at just the maximum temperature to which the resistor may be brought, the efficiency of the furnace *for melting* becomes zero. A tubular resistor-type furnace will give in an empty chamber a high temperature very quickly, but it is, on the other hand, an inherently inefficient fusion furnace, which becomes rapidly more inefficient as the temperature required for fusion approaches the safe operating temperature of the resistor heater.

The above rather discouraging considerations led the writer to make two inquiries: first, what form would an ideal furnace take, and, second, is it physically possible to reach this ideal electrically?

Conception of an Ideal Furnace

The writer's conception of the ideal melting furnace is one which consists of a crucible of cylindrical form (so proportioned that the ratio of its radiating surface to its volume is a minimum) that contains the product to be melted, either electrically conducting or insulating. This product by induction alone should be capable of absorbing a large percentage of the power available, and thereby become quickly and uniformly heated until fusion with any desired superheat is obtained. The heat supplied in this ideal furnace should first and only make its appearance directly in the walls of the crucible, or, better, within the contents of the crucible. As power is continually supplied the temperature should rise and loss of heat by outward conduction and radiation should be negligible. The final possible temperature attainable should not be lower than a necessary limit set by the refractory properties of the crucible itself. A large percentage of the power supplied electrically and metered at its source should become directly transformed *within* the crucible into heat and not *pass* into the crucible from the outside by a process of heat conduction.

If this ideal furnace is to be in part or wholly realized it must be by some form of induction, obtained without the use of iron, for reasons which appear below.

The customary form of construction of the induction furnace does not permit the attainment of this ideal furnace in several particulars:

1. An electric circuit and an iron magnetic circuit are always interlinked. Thus, a circuit of metal is always interlinked with a complete or an approximate circuit of iron. This latter carries a primary winding, and the circuit of metal constitutes the secondary of a step-down transformer. This threading through the electric circuit of an iron magnetic circuit precludes the possibility of realizing the simple crucible form of construction above described.

2. The difference between the expansion with temperature of metals and refractories makes it practically impossible, without destroying the latter, to allow the ordinary induction furnace to cool down to where its charge solidifies. Refractory linings are invariably cracked when this is done. The furnace must be started with pre-melted material, and its charge must be removed before it is allowed to freeze.

3. The induction furnace constitutes a step-down transformer which necessarily has large magnetic leakage. The power factor may, therefore, be very low, the supply current lagging behind its e.m.f.

4. Very high temperatures cannot be obtained in the ordinary type of induction furnace because, if energy is supplied fast enough to replace the heat losses at high temperature, the molten material is ruptured by the mutual attraction of current elements. The limit is set for obtaining high temperatures by what Dr. Carl Hering has called the "pinch effect."

5. The ordinary induction furnace does not lend itself to such form of construction that the contents may be heated in controllable atmospheres or in vacuum.

With these limitations of the ordinary induction furnace in mind, the writer sought the underlying principle which would permit the attainment by electric induction of the ideal type of simple crucible furnace. This principle has been found, and a 20-kw. furnace embodying the principle has been made and very thoroughly studied. The furnace is a complete success. The principle upon which it operates will now be very briefly described.

Principle of Operation

Heating is obtained by inducing, with comparatively high frequency currents in an inductor coil which surrounds the crucible, very large currents in the walls of the crucible or in its contents, if these are electrically conducting. The induction is obtained by electromagnetic induction without the use of any iron. The furnace differs radically from all other types of induction furnace by the entire absence of any interlinkage of a magnetic with an electric circuit. The necessary high frequency of the inducing current may be obtained in more ways than one. The simplest and most obvious method is to employ oscillatory currents obtained from the discharge of condensers. These oscillatory currents pass through an inductor coil of about fifty turns which surrounds the crucible, and sufficiently separated from it to permit of both electrical and heat insulation. We thus have in effect a Tesla coil arrangement in which the voltage is transformed down and the current transformed up. It is to be noted that when a condenser of capacity C is charged to voltage V, energy is stored in the dielectric in potential form and in amount $\frac{1}{2}CV^2$. When the condenser is discharged this potential energy is released, and, becoming kinetic, may take the form of electric radiation as utilized in radio practice, or it may take the form of thermal energy or heat. When this principle is once recognized it becomes purely a question of design and engineering practice so to construct apparatus and select conditions that very little energy is spent in radiation and a large percentage of energy is converted into heat within a crucible and its contents—the necessity of the interlinkage of an iron magnetic circuit with an electric circuit being entirely obviated.

Apparatus consisting of adjustable reactances, high tension transformers, and an entirely new type of discharge gap (which is nearly silent and operates without moving parts), two blanks of condensers and a furnace inductor winding, constitutes a complete outfit for operation on a two-phase, 60-cycle, 220 volt supply circuit.

Fig. 1 is a general view of an assembler 20-kw. furnace of the vacuum type.

Fig. 2 shows a metal-melting furnace with its outer protecting case removed to reveal its construction.

The results so far obtained with this furnace (which is considered only as a model, since it is contemplated to construct this type of furnace in 50 or 60-kw. units) are about as follows:

1. It operates on a two-phase circuit, drawing an equal load from each phase.

2. It operates at full load with unity power factor for the supply circuit or with a slightly leading current.

3. It operates at any small fraction of full load without appreciable reduction in efficiency.

4. The metal-melting furnace will melt, starting at room temperature, about 45 lb. of brass in thirty-five minutes when watt-hour meters in the supply mains register a total power supplied of 18 kw.

5. The vacuum-type furnace, illustrated in Fig. 1, will bring a crucible of Acheson graphite 14 cm. in diameter and 18 cm. high, filled with tin or glass, to a temperature of well over 1600 deg. C. in forty to fifty minutes, and a vacuum of not less than 1 cm. of mercury can be maintained during the process. It should be stated, however, that certain kinds of glass evolve a

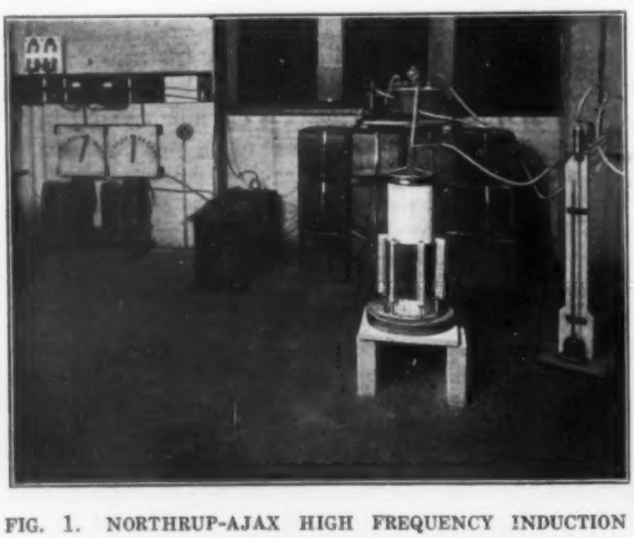


FIG. 1. NORTHRUP-AJAX HIGH FREQUENCY INDUCTION FURNACE. GENERAL VIEW OF VACUUM TYPE

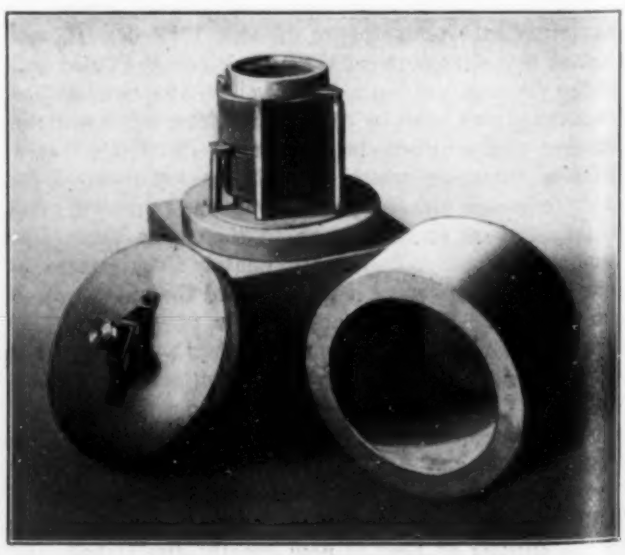


FIG. 2. NORTHRUP-AJAX FURNACE. METAL MELTING TYPE

vapor under reduced pressure which diminishes the vacuum and makes the glass frothy.

6. Cylinders or crucibles of the above dimensions or smaller, made of graphite can be raised to a temperature of 1600 deg. C. with an almost perfect uniformity in their temperature distribution. Cylinders of other materials, as of iron, nickel, or nichrome, may be raised in temperature until they start to melt.

7. The thermal efficiency, defined as the ratio of heat energy developed within the crucible and its contents to kilowatt hours supplied at switch terminals (both expressed in like units), may be made as high as 60 per cent with the 20-kw. furnace illustrated, and it is thought that a greater thermal efficiency may be obtained in a furnace of larger power capacity.

The melting of platinum in vacuum has not yet been accomplished, but it is expected that this result will be attained when certain required devices have been constructed.

Progress in Electric Heating

It is to be noted here that as progress in power and lighting distribution has come with increase in line voltage, so we may expect progress in electric heating by utilizing higher voltages. The progress already attained has been reached by heating with induction at high voltage, and only a beginning has been made in a direction which gives rich promise of further development.

The furnace here illustrated has been operated at 5400 and at 7200 volts at the condenser terminals. The frequency is the natural period of the oscillatory circuit of either phase. About equally good results have been obtained when working with 25,400 cycles and with 12,500 cycles per second.

Protection from the high voltage is secured by surrounding the furnace casing with a grounded metal cage, and the crucible, in addition to being electrically insulated from the inductor coil with a cylinder of quartz glass, is likewise grounded.

The furnace above described and illustrated comes very near to a realization of the "ideal furnace" which we have pictured.

This furnace was developed by the writer for, and with the financial support of, the Ajax Metal Company of Philadelphia, Pa. The development was made in, and with the facilities of, the Palmer Physical Laboratory of Princeton University.

The early construction of furnaces of larger kilowatt capacity is under contemplation. These furnaces should be particularly adapted to the melting of optical glass, high melting alloys, brass, gold, silver, etc.

It has been shown experimentally that by means of electromagnetic induction at high frequency, metal scrap, borings, turnings, etc., may be quickly raised to a melting temperature, then fused and superheated, even when contained in a refractory crucible of nonconducting material. Currents circulate in the subdivided mass, jumping with unnumerable small arcs the contact resistances between particles. In this manner pure electrolytic iron, contained in a magnesia crucible, has been fused in vacuum, carbon and presumably every other source of contamination being entirely absent.

Finally, it is worthy of statement that we have in this method of heating a type of furnace which it is impossible to destroy by burning out, as the only parts which get at all hot are the crucible, its contents, and the immediate layers of refractory lining. A layer of heat insulation of "silox" about 1 cm. thick surrounds the crucible, and this has been found quite sufficient to maintain the inductor coil below a red heat when the crucible and its contents are above 1400 deg. C.

It is hoped that eventually, by using greater power input, it will be possible to melt metals in vacuum belonging to the tungsten group, and therefore make it possible to produce, free from carbon, any kind of very high melting alloy.

The Measurement of High Temperature

We must here confine our remarks to the measurement of high temperature by means of direct insertion pyrometers, excluding from consideration the extensive subjects of radiation and optical pyrometry.

The limits to accuracy set for high-temperature direct-insertion pyrometers are determined chiefly by the inevitable chemical modification of the pyrometric substance rather than by its fusion or destruction. With the best types of pyrometer-casing tubes which are at present obtainable, at a temperature in the neighborhood of 1350 deg. C. gases obtain access to the thermocouple wires, and contamination is produced by the chemical activity of the hot gases. If the pyrometer is inserted in a reducing atmosphere, this contamination is particularly marked. Thus the writer has never been able to use successfully, except for very intermittent service, a platinum-rhodium thermocouple in a reducing atmosphere much above the melting point of nickel. A thermocouple of tungsten-molybdenum, though giving but a feeble e.m.f., can be used to measure extreme temperatures if it can be protected from access of hot gases.

Up to about 1300 deg. C. the accurate measurement of temperature in any kind of atmosphere has been satisfactorily solved by properly constructed and protected platinum-rhodium thermocouples, the e.m.f. of which is determined by a potentiometer method. As a potentiometer is a somewhat delicate instrument to take into the factory, and as a direct deflection galvanometer, or millivoltmeter, must be intrinsically sensitive to measure the feeble e.m.f. of a platinum-rhodium couple, the writer deemed it highly desirable to

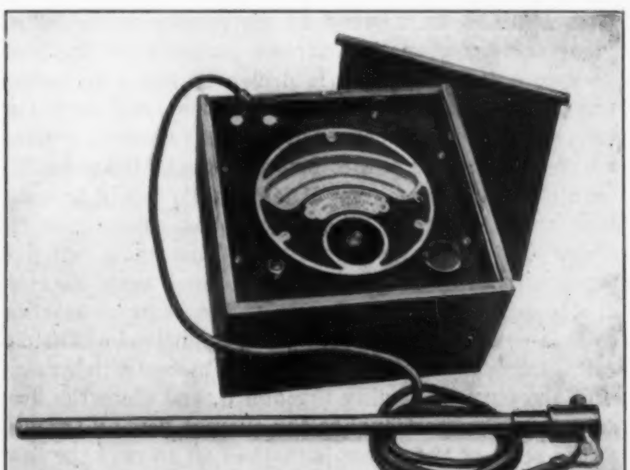


FIG. 3. PYROVOLTER. COMPLETE WITH SPECIAL THERMOCOUPLE

Pyrovolter Circuits

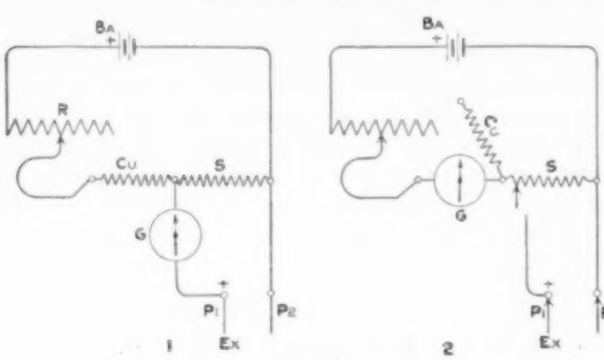


FIG. 4

devise a robust portable instrument which would operate on the potentiometer principle, but give readings in millivolts or degrees by the deflection of a pointer. The instrument devised for this purpose has the appearance and all the rugged characteristics of a voltmeter. It is marketed under the name "Northrup Pyrovolter." The instrument is illustrated in Fig. 3.

The principle upon which the pyrovolter operates may be very briefly described as follows:

Referring to Diagram I, Fig. 4, a small dry cell *B*A, contained in the case of the instrument, sends a current through the rheostat *R* and the fixed resistances *C*U (which is equal in value to the resistance of the copper coil of the moving element of the meter *G*), and *S*, a fixed resistance of manganin adjusted accurately with potential tap offs. The value of the resistance included between these potential leads determines the range of the instrument. The current flowing through *S* is varied by the rheostat *R*, so that a varying e.m.f. is applied to these potential leads due to the drop of potential over the resistance *S*. The moving element is connected in series with the unknown e.m.f., *E*X (through the binding posts P_1 and P_2), across this varying potential, so that the meter serves as a galvanometer to establish a balance between the unknown *E*X and the drop across *S*. This adjustment is effected by turning the large black button (marked "Off") in the lower right corner of the instrument, in a clockwise direction, to increase the current flow through *S*, thus increasing the drop across *S*. When the balance has been attained, as is shown by the pointer of the instrument resting over the extreme left end of the scale (where a long, fine line is drawn to assist in setting the pointer accurately for this balance), the small button in the lower left corner of the instrument is pressed, which changes the connections to those of Diagram 2.

In the new connections (Diagram 2), it will be noted that the pressing of the button has substituted the meter *G* for the resistance *C*U. This substitution is permissible for all temperatures, since both elements are copper and hence always of the same resistance; so that now without affecting the conditions of the circuits, there has been introduced a meter which measures the current flowing through *S*, and since the drop across *S* is proportional to the current flowing through *S*, the scale of the meter is marked off to read the drop across *S*, and this drop having been just balanced against *E*X, we have the instrument indicating the value of *E*X.

In effect, the pyrovolter principle provides a means of operating a deflection instrument on the potentiometer principle, wherein the accuracy and permanence of the instrument basically depend upon a permanent magnet rather than upon a standard cell, in that the "current constant" of the instrument is all that affects the readings, the resistance *S* being once fixed. The practicability of the principle is at once evident, since the permanence of a permanent magnet is the basis of the calibration of the instrument.

Some of the advantages secured with this type of instrument for measuring millivolts by reading a deflection, and consequently the corresponding temperature indicated by either a base or noble metal thermocouple, may be enumerated as follows: Sufficient sensibility is secured in a rugged instrument so that temperatures indicated with platinum-rhodium couples may be read with satisfactory accuracy. As the instrument operates on a potentiometer principle, the resistance of the thermocouple itself and the thermocouple leads may vary within wide limits without affecting the accuracy of the readings. The instrument is not limited to a single range, but as many as four ranges may be conveniently embodied in one instrument. The indications of the pyrovolter are theoretically and practically independent of the temperature coefficient of the instrument itself.

Though thermocouple methods of reading temperatures meet most of the requirements of laboratory and factory up to the safe working temperature limit of the platinum-rhodium couple, there are many industrial operations, carried on at higher temperatures, where a direct-insertion pyrometer which measures these accurately would be very welcome.

Nature has provided us with a pyrometric substance which promises to give the result desired. This pyrometric substance is the metal tin. It possesses among the metals some unique characteristics. Tin melts at 232 deg. C., and the writer knows from personal study that it does not evaporate appreciably nor boil at 1680 deg. C. According to a determination by Greenwood[1] its boiling point is 2270 deg. C. Thus the range of temperature in which tin is molten, about 2000 deg. C., is greater than that of any other known substance. Tin does not form a carbide in the presence of graphite, and maintains its purity in an atmosphere of CO at the highest temperature at which it is molten. To these properties are added others which particularly adapt it to pyrometric uses. Thus, it increases in resistivity when in the molten state, and also in volume in a strictly linear manner within increase of temperature. At least this is true up to the highest temperature at which accurate observations have been made, which is 1680 deg. C.

The writer has taken advantage of these characteristics of pure tin for measuring temperatures above 1600 deg. C. and as low as the solidification-point of tin. He has used a method employing the increase in the resistivity of tin with temperature, and has developed in this connection an instrument called a "resistometer."[2] More recently he has developed a tin-pyrometer which depends for its indication upon the linear expansion of tin. The instrument is constructed on

[1]*Chemical News*, 100, 1909.

[2]"New Method of Measuring Resistivity of Molten Materials: Results for Certain Alloys," by E. F. Northrup and R. G. Sherwood, *Journal of the Franklin Institute*, October, 1916.

the general lines of a very large mercury thermometer. A first instrument which was recently constructed for industrial use to measure the temperature of a brick furnace is illustrated in Fig. 5. The pyrometer is shown in cross-section in Fig. 6.

The tin is contained in a "bulb" of close-grained graphite, and it expands, when the temperature exceeds about 700 deg. C., into the graphite "stem." The height at which the column of tin stands is determined, in the present form of instrument, by electrical contact. The scale is laid off or calibrated by noting the height of the column of tin at some two temperatures chosen within the range of a platinum-rhodium couple. The scale is extended above the higher temperature upon the assumption that the expansion continues linear to the highest temperature for which the combination, graphite and tin, is suitable. The upper obtainable limit of temperature to which it is practical to go has not been actually determined, but it is known from personal observation that this limit is higher than 1680 deg. C., and it is thought to lie well above 1800 deg. C.

This pyrometer does not indicate, as a thermocouple does, a point-temperature, but registers the mean temperature over the space occupied by the pyrometer bulb.

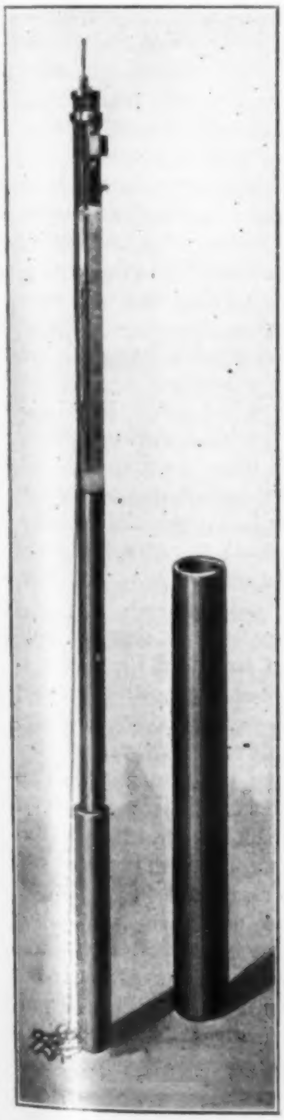


FIG. 5. TIN PYROMETER AND OUTER CASING TUBE

There does not appear to be any serious difficulty in sight in preventing the graphite from oxidizing and slowly wasting away. To prevent this it is proposed to inclose the bulb and a portion of the stem in a tube closed at the bottom of a carborundum composition ("r e f r a x," "silfrax" or "carbofrax," as made by the Carborundum Company of Niagara Falls). In the small clearance space between the bulb and the inside of this tube there may be inserted a filling of molten tin or a high-melting glass. This jacket of molten tin or glass is expected to make a perfect shield against the attack of oxidizing gases upon the graphite of the bulb. Of course, this type of pyrometer is intended only for permanent installation in an industrial furnace of comparatively large dimensions, and the tin-pyrometer as now constructed must be maintained approximately in a vertical position.

It should be stated that while the writer has the highest confidence in the future practical application of this very high temperature direct-insertion pyrometer, it has not, at the present writing, been tried out in industrial situations, so that it may be pronounced a proved commercial success—but the principle is correct and further developments are quite sure to follow.

In closing, the writer would urge upon all investigators in the field of high temperature to consider the great possibilities of the metal tin for extending the fundamental temperature s c a l e above 1550 deg. C., the present limit of the g a s thermometer. Tin can be obtained as pure as nitrogen gas, and when in the molten state is quite as independent as a gas of its past physical h i s t o r y. Only chemical contamination and temperature can affect either its resistance-change or its volume-expansion, and its chemical purity is easily controlled. Its resistance-increase and its expansion characteristics are, we firmly believe, as regular as is the increase in pressure of a gas of c o n s t a n t volume when its temperature is increased. Pure g r a p h i t e, which makes an ideal container for tin, has an almost negligible expansion, and it is certain that both tin and graphite are undisturbed by a temperature elevation which goes far beyond that at which any gas can be used pyrometrically.

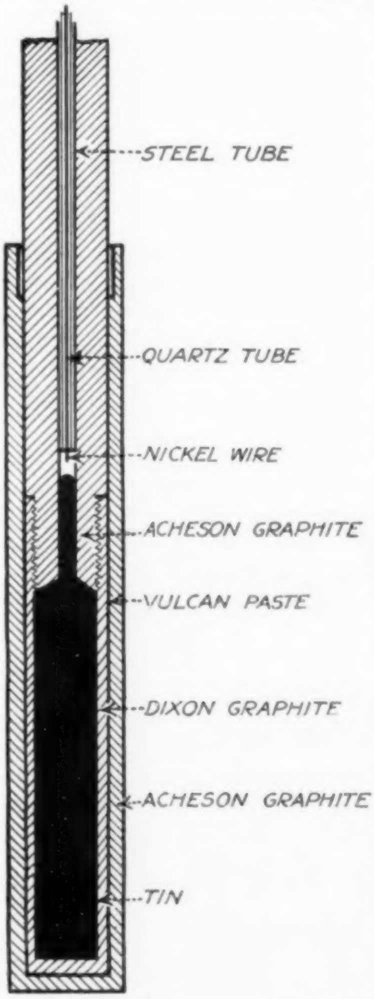


FIG. 6. CROSS SECTION OF TIN PYROMETER

Pyrolectric Instrument Co.,
Trenton, N. J.

Pyrometer Standardization

This subject was discussed by Messrs. EZER GRIFFITHS and F. H. SCHOFIELD of the National Physical Laboratory. The authors state it is now generally agreed that the standard scale of temperature should be the thermodynamic. The advantage of this from the practical point of view is that it permits of the evaluation of high temperatures, on the basis of the radiation laws, on a scale consistent with that obtained by means of the gas thermometer at lower temperatures. The problem of pyrometer standardization resolves itself to an empirical calibration of the pyrometer, whether mercurial, thermo-electrical, or radiation, by comparison with a gas thermometer. The steps by which the scale of a pyrometer is obtained are generally as follows: (1)

The gas-thermometer worker makes a comparison of his instrument with a thermo-element. (2) This calibrated thermo-element is then employed to determine the freezing points of a number of pure metals. (3) The observer who wishes to calibrate a pyrometer standardizes a thermo-element by freezing-point determinations, assuming the values given by the gas-thermometer worker for these transition points. (4) The pyrometer and thermo-element are then compared under suitable conditions. Examples of this procedure are given in the paper.

The Automatic Control and Measurement of High Temperatures

BY RICHARD P. BROWN

The author shows the industrial need of methods of automatic temperature control and the feeling of security that comes to a works manager whose plant is thus equipped. His experience shows that for temperature measurements up to 800 deg. Fahr. or 425 deg. C., an instrument actuated by the expansion of nitrogen gas is most satisfactory.

For use at moderate temperatures, where the measuring instrument must be placed at a considerable distance and for temperatures above the range of the gas expansion instrument, the thermo-electric pyrometer has been almost universally adopted in the United States. A thermo-couple of base metals, usually formed of one wire of 90 per cent nickel and 10 per cent chromium, and the other wire 98 per cent nickel and 2 per cent aluminium, is preferred for temperatures up to 1800 deg. Fahr. or 1000 deg. C. For temperatures above this, and as high as 2800 deg. Fahr. or 1500 deg. C., thermo-electric pyrometers using a platinum-rhodium thermo-couple are the most satisfactory. For higher temperatures still, a radiation type of pyrometer is available, consisting of a thermo-couple in the focus of a reflector at the rear end of the tube, which is pointed at the door or opening of the furnace.

For measuring the voltage produced by a thermo-couple, whether of base metal, platinum-rhodium, or the radiation type, high resistance millivoltmeters are available. Such millivoltmeters are produced by us in the United States, of some 1000 ohms or more. This remarkably high resistance is naturally desirable to practically eliminate the errors due to changes in the resistance of the line or wiring connecting the thermo-couples and the instrument, and also to nullify the effects of any changes in the resistance of the thermo-couples, due to heating.

Changes in resistance may be due to actual changes in length or changes in atmospheric temperature, which in turn affect the resistance of the line or wiring. We have been able to secure this exceedingly high resistance by reducing the weight of the moving element to a minimum.

The total weight of the moving element in our high resistance pyrometer, including pointer and springs is 526 mg. This extreme lightness is secured by the use of an aluminium alloy wire, which we have succeeded in enameling. The enamel coating is much thinner than the silk insulation formerly used and more turns can be secured on a coil of a given width. Likewise by the use of the aluminium wire, the weight has been reduced 66 2/3 per cent as compared with copper wire which was formerly used for these moving elements. The aluminium wire is .003 in. in diameter, and drawing this wire has been quite a mechanical problem.

The pointed tubing in this moving element is of aluminium with an inside diameter of .008 in. and an outside diameter of .012 in., or a total thickness for the wall of the tubing of .002 in. Even this weight for the pointer tubing could probably be reduced by the use of magnesium instead of aluminium, but to date we have been unable to satisfactorily draw magnesium.

I only cite these points regarding the construction of our present-day high resistance pyrometer millivoltmeter to show what development work can produce. Instruments of this type made by Siemens & Halske of Germany were never developed to this extent, at least prior to the outbreak of the war, and their moving element was several times as heavy as the one described, and in consequence the resistance of their pivoted meter was several times less. Incidentally, I think we have about reached the limit of development work along this particular line.

It will be understood that the same electrical system, such as I have described, can be used either to indicate the temperature or, combined with the proper apparatus, to record the temperature constantly on a recording sheet. There are both portable and wall type indicating pyrometers, and recording pyrometers are produced to make a record on a circular chart 8 in. in diameter, or to make a continuous record of the temperature on a roll of paper lasting two months or more. By the introduction of suitable switching mechanism a record of the temperature of quite a number of thermo-couples can be made on the same record sheet. These temperature records are distinguished by using different colors for each record line, by using numbers corresponding to each thermo-couple, or changing the form of line produced on the chart for identification.

New Heat Meter

For even greater precision in temperature measurements than is secured with the high resistance millivoltmeter, I have developed a new instrument which we call the Brown heat meter. This instrument is suitable for either temperature measurement or automatic control of temperature, and a brief description of this new instrument might be of interest.

My idea in the heat meter has been to eliminate all the bad features or draw-backs met with in using a millivoltmeter for temperature measurement. Possible sources of error in the use of a millivoltmeter in temperature measurements, even one of high resistance, consist in changes in resistance of the circuit comprising the thermo-couple and the leads or wiring, due to changes in length or atmospheric changes in temperature; also errors can occur due to temperature coefficient of the meter—that is, errors caused by atmospheric changes in temperature of the meter itself. Another source of error is a change in the actual indication of the instrument due to spring fatigue, abuse or sticking. To overcome these possible sources of error we have developed this rather interesting instrument.

Briefly, its operation is as follows: With our standard millivoltmeter of high resistance we supply an ordinary dry cell about $1\frac{1}{8}$ in. in diameter by $2\frac{1}{2}$ in. long and furnish suitable rheostats to reduce the voltage of the dry cell from approximately $1\frac{1}{2}$ volts to a range

from 0 to 60 millivolts, the voltage produced as a maximum by the thermo-couples.

In our first operation we oppose the voltage developed by the thermo-couple to the reduced voltage of the dry cell, and when the pointer stands at zero it indicates that the voltage from each source is equal. We now in a second operation cut out with a switch the voltage of the thermo-couple and read the voltage of the dry-cell circuit by direct deflection. This eliminates the line resistance entirely as in a potentiometer.

We have now a deflection indicating the actual temperature developed by the thermo-couple at the moment of reading the instrument, but fluctuations in temperature of the thermo-couple will not be indicated, as we are reading the voltage from the dry cell. We have, however, incorporated other operations in this meter.

In a third operation we connect the thermo-couple to the meter instead of the dry-cell circuit and we note whether the indications are the same. By switching back and forth quickly the voltage from the thermo-couple circuit or from the dry-cell circuit can be noted. If excessive line resistance has caused the indications of the millivoltmeter to be lowered as compared with the dry-cell circuit, a rheostat is operated to bring up the indications of the thermo-couple circuit to that shown when we are reading the voltage of the dry-cell circuit.

We now leave the instrument indicating on the thermo-couple circuit; and the errors, if any, which might be due to line resistance or changes in temperature of the line have been eliminated, and we have a direct-reading millivoltmeter, indicating the correct temperature.

A rheostat is supplied in the meter of 15 ohms, which permits of adjusting the indications for a total change of line resistance equivalent to 15 ohms, or a circuit of two copper wires almost a mile long.

We have eliminated the temperature coefficient of the meter by furnishing a copper resistor in the meter equivalent to the copper or aluminium of the coil; hence, in balancing the voltage from the dry cell against that of the thermo-couple we also automatically eliminate errors due to the temperature coefficient of the meter.

There is now left only one possible source of error, the change in the actual indications of the meter due to sticking of the pointer, abuse of the instrument, spring fatigue, etc. To obviate this source of error we can supply with the instrument a standard cell with suitable resistors, and in the same manner as the meter can be tested by the potentiometer method, we can check this meter. We supply three resistors; for example, where a meter is calibrated for 60 millivolts we furnish resistors equivalent to a deflection of 20, 40 or 60 millivolts on the scale, and after balancing the standard cell against a part of the voltage of the dry cell, through these suitable resistors we can note whether the pointer swings to 20, 40 and 60 millivolts respectively on the scale. If it does not, the error can be noted and the actual error in calibration is detected.

Where the instrument is supplied with standard cell the temperature of the instrument should always be between 5 deg. C. and 40 deg. C. or 40 deg. Fahr. and 105 deg. Fahr. In fact, standa[illegible] phate or zinc sulphate will be injured if the temperature rises or falls beyond these limits. This is true of any standard cell employed in instruments

In this instrument we have all the good features of the potentiometer method of measuring temperature with the advantage that we have a direct-reading instrument which can be adjusted once every day or oftener if desired, for the actual line resistance with which it is used, and in the surrounding atmospheric conditions. The meter will then indicate correctly throughout the whole scale range, and the furnace man has the instrument to guide him without hand manipulation, and an inspector can daily check the calibration of the instrument.

Naturally, this instrument is equally as suitable for automatic temperature control as the instruments previously described when properly designed for this service.

Automatic Temperature Control

Attempts have been made in the past to electrically operate switches and valves by permitting the pointer of the pyrometer to come in contact with adjustable contact arms on each side of the pointer. Unfortunately the millivoltmeter, used with the thermo-electric pyrometer, has an exceedingly weak control for the pointer. One is easily able to blow the pointer across the scale with the breath.

In consequence, simply permitting the pointer of such a pyrometer to move into contact is not sufficiently positive to be satisfactory for automatic control work.

The automatic control pyrometer operates in the following manner: A thermo-couple formed of a nickel-chromium alloy is installed in the electric furnace, the temperature of which is being controlled. The thermo-couple actuates a high resistance millivoltmeter. Below the pointer and adjustable throughout the whole scale range is a table carrying two contact pieces, separated by a thin piece of insulating material 1/32 in. thick. The depressor arm, driven by a small electric motor or by a clock if preferred, depresses the pointer at regular intervals, usually every ten seconds, and in doing so the pointer forces together the two contact pieces below.

Let us assume the pyrometer controller is required to control the furnace at a temperature of exactly 1400 deg. Fahr. The knob on the left of the instrument is turned until the index in front of the scale stands at 1400 deg. Fahr. This index corresponds to the position of the thin insulating material which separates the high and low contact.

The switch connecting the furnace in the line is closed and the pointer slowly rises across the scale as the temperature of the furnace rises. As the switch is already closed, when the pointer is depressed on the low contact, the switch continues to remain closed, and no change occurs until the pointer passes over the neutral insulating piece and is depressed on the high contact. The switch indirectly operated by a solenoid and relay is now instantly actuated and the circuit opened. The temperature of the furnace begins to slowly fall, and when the pointer is again depressed on the low contact the circuit is again closed. This operation continues as long as the furnace is to be operated.

When the switch opens and closes the main circuit the current in consequence is either full on or off and the fluctuations are continuous within narrow limits of some 10 deg. to 20 deg. Fahr. These continuous risings and fallings of temperature can be largely reduced and closer control can be procured by the use of two rheo-

stats in the furnace line. The solenoid-operated automatic switch is then used to simply cut in and out of circuit the second rheostat.

Assuming it is desirable to continually maintain 1400 deg. Fahr in the electric furnace, irrespective of fluctuations of voltage, the two rheostats are set so that with only one rheostat in the circuit the temperature will rise to approximately 1500 deg. Fahr. With the second rheostat in the circuit the temperature drops to 1300 deg. Fahr.

When we now use the solenoid-operated switch to cut in and out the second rheostat, we naturally control the temperature only between 1500 deg. and 1300 deg. Fahr., and we do not have the rapid surges or ups and downs in temperature, and maximum control is secured.

It is realized that the same form of switch can be used to operate a valve to control a gas or oil furnace. We have found it desirable to use an automatic valve in a by-pass so as to simply control a portion of the gas or oil supply, and in the same manner as in the electric furnace control, eliminate the maximum fluctuations caused by the complete opening and closing of the switch or valve.

Assuming that we have a 2-in. supply pipe for the gas to the furnace, it is customary for us to by-pass this and use a ½-in. automatic valve, which gives us approximately 25 per cent control. This is sufficient to control the usual fluctuations in gas supply and secure very satisfactory control. This method also eliminates the difficulty which would occur where the gas is completely shut off and then turned on in full, as would occur without the by-pass control.

Temperature Signaling Pyrometer

In addition to an instrument to automatically control furnace temperatures there has been a demand for an instrument to automatically signal by lights whether the temperature is too high, correct, or too low in any particular furnace.

It has been common practice in plants in the United States, where there are a number of heat-treating furnaces, to maintain an operator at a central pyrometer, and by colored electric lights at the furnace to signal whether the temperatures are right or not. It is common practice to locate three lights above each furnace—red, white and green; the red light burns when the temperature is too low, the white light when the temperature is within certain limits, for example, 20 deg. Fahr. of the correct temperature, and the green light burns when the temperature is too high. The fireman who operates the furnace is guided entirely by the lights and a central pyrometer is used to control the temperatures.

We have been able to develop an instrument to automatically signal whether the temperature is correct or not by lights, and in this way the services of the operator at the instrument are eliminated. The same form of instrument is used for this purpose as we use to automatically control the furnace temperatures, and the pointer is depressed at intervals of every ten seconds on to contacts corresponding to the red, white and green lights.

No special battery or other source of current than an ordinary service line is required to operate these lights. The supply may be 110 or 220 volts, either A.C. or D.C. The current which lights the lamps does not flow through the instrument, but is made and broken by an auxiliary device containing the necessary mechanism. A high resistor is in series with the circuit connected with the pyrometer, which reduces the current flowing through the contactors within the instrument to less than .07 amp. This prevents sparking at the contactors and errors due to the heating effect of a current of higher amperage. The lamps may be any reasonable distance from the pyrometer; in fact, they are operative at a mile or more if desired.

The various thermo-couples in each furnace are connected successively to the instrument through switching mechanism, and at the same time a switching mechanism connects the various sets of lights at each furnace. We have constructed an instrument of this character to automatically take care of signal lights at twelve furnaces.

This form of equipment gives the fireman or operator of the furnace an indication by lights which he can easily understand, and he adjusts the valves or fires the furnaces accordingly. It is a simple method to instruct a man to keep the white lights burning and to explain what the red and green lights mean, and a less experienced workman can control the furnaces in this manner than where one is required who can read temperatures on a pyrometer scale. This newly developed instrument also eliminates the man to read the temperatures at the central pyrometer.

The extensive use of pyrometers to measure or record high temperatures will serve

(1) To eliminate guesswork as to the temperature;

(2) To reduce fuel consumption through the maintenance of the correct temperature and not excessively high temperatures;

(3) To reduce time for heating of the product due to the maintenance of the correct temperature; and

(4) To increase efficiency in operating a plant through the savings outlined above.

Instruments to automatically control the temperature, when properly constructed and applied, will eliminate entirely the personal element. The maintenance of the correct temperature in the furnace is automatic, and this is one step further, and in consequence an improvement over temperature control through pyrometers.

I do not doubt but that the next few years will see further improvements in pyrometers and temperature control. There will always be room for improvement and the co-operation of the industrial works and pyrometer manufacturers will largely hasten the development of practical instruments for the measurement and control of high temperatures.

Brown Instrument Co.,
Philadelphia, Pa.

Civil Engineers Welcomed to United Engineering Societies Building.—Fitting ceremonies marked the formal association of the American Society of Civil Engineers into the fraternity of the Founder Societies at the Engineering Societies' Building in New York on Friday, Dec. 7. An addition to the building has recently been completed for the occupancy of the Civil Engineers. The Mining, Mechanical, Electrical and Civil Engineering Societies are now all under one roof in the great Engineering Societies' Building. The library of the Civil Engineers has been added to the Engineering Societies' Library.

The Nebraska Potash Industry

By Ernest E. Thum

The western edge of the Nebraska "Sand Hills" region is now producing daily about 350 tons of salts containing 25 per cent of water-soluble K_2O, or at the rate of 32,000 tons of K_2O per annum. This shows a remarkable gain over the production of the district for the year 1916, which is included in the first item of Table I, taken from H. S. Gale's report on "Potash in 1916," a part of Mineral Resources of the United States, 1916, Part II.

TABLE I.
SUMMARY OF POTASH PRODUCED IN 1916

Source	Water Soluble K_2O Tons	Water Soluble K_2O Value
Natural salts or brines	3,994	$1,937,600
Alunite and silicate rocks, including furnace dust	1,850	715,000
Kelp	1,556	781,100
Wood ashes	412	270,000
Distillery wastes	1,845	500,900
Miscellaneous organic sources	63	38,130
	9,720	$4,242,730

The present production of potash from Nebraska is seen to be at more than three times the rate of that of the whole country during 1916, which itself was some ten times the total production of 1915. There is still a large gap to fill, however, before the normal United States consumption is attained, which amounted to about 275,000 tons annually for the four years 1910 to 1913, inclusive.

Description of Deposits

An area of about 8000 square miles of the north central portion of Nebraska is covered with a succession of low sand dunes. This region is bounded on the north by the Niobrara River and on the south by the North Platte River (Fig. 1), which rivers apparently were the barriers of the prairie and forest fires that are thought to be partly responsible for the present topography.

According to A. C. Whitford, the origin of the hills is as follows: At the close of the Glacial epoch there were one or possibly two large rivers running eastward across Nebraska which overflowed their banks periodically and produced very extensive flood plains. At the close of each periodical inundation there followed a long drought accompanied by high westerly winds. This state of affairs piled up sand dunes similar to those along Lake Michigan and caused the present topography of the sandhill region. Later, when the present climate came, the hills gradually grassed over and were possibly forested, which vegetation became the subject of Indian fires. The burning off of large tracts caused secondary shifting of the sand and to some small extent the present contour of the hills.

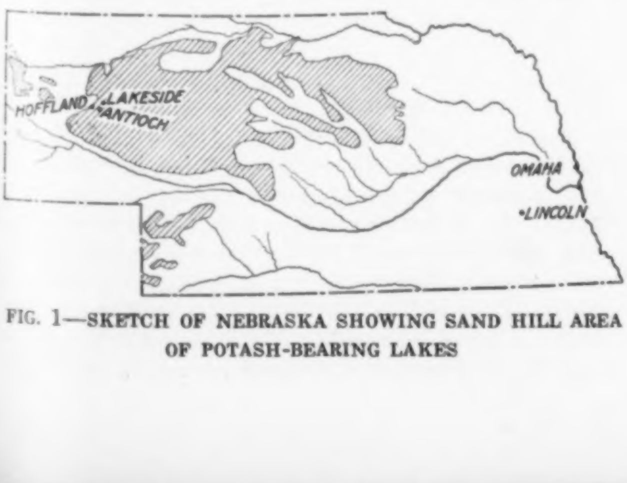


FIG. 1—SKETCH OF NEBRASKA SHOWING SAND HILL AREA OF POTASH-BEARING LAKES

The genesis of the sand is thought to be a feldspathic igneous rock, inasmuch as the grassy hill vegetation is much more luxuriant than that of the table lands on the borders, making an ideal cattle-grazing area.

At frequent intervals in this sand hill area are found flat-bottomed "sinks" in which the grass grows waist high, and which usually contain a shallow lake of variable extent. These wind-swept bowls form land-locked basins, collecting the surface drainage of a small area—from one to ten square miles, infrequently more.

The yearly precipitation of this region is from 15 to 18 in., while the evaporation is probably of the order of four times as much. It will thus be seen that the superficial area of any lake will be subjected to extreme fluctuation, increasing through an open winter and spring, and decreasing through the hot summer. The saline content of the waters of each lake will vary, not only from that of its neighbors, on account of its size, age and depth, but from month to month, depending upon whether the lake is full or nearly dry. Some of the lakes, whether on account of large size, youth or the possession of an underground outlet, are quite fresh. All stages of alkalinity may be observed up to absolute saturation, while the content of potash in the dissolved salts also shows extreme variation, as is shown in Table II, from analyses by the United State Geological Survey and J. H. Show of the Potash Products Company.

TABLE II.

Sample No.	Location	Per Cent Dry Salts in Sample	Per Cent K_2O in Dry Salts
1	Middle of Jesse Lake	13.55	29.97
2	Sec. 17, T. 26 N., R. 43 W	3.21	35.85
3	Sec. 19, T. 26 N., R. 44 W. small lake	8.15	15.50
4	Large lake in same section	4.70	31.40
5	Three miles east of Reno	7.20	23.13
6	Sec. 20, T. 20 N., R. 44 W	4.56	31.56
7	McCarthy Lake	8.83	30.62
8	Pond, ½ mile south of above	8.11	19.82
9	Richardson Lake	7.57	14.44
10	Sec. 1, T. 21 N., R. 46 W	3.33	16.61
11	Thompson Lake	4.30	19.68
12		9.54	10.88
13		7.86	19.98
14		2.04	18.78
15		10.61	22.43
16		8.31	8.96
17		2.68	16.68
18		3.43	29.64
19		3.42	15.26
20		3.70	14.50
21		3.27	34.93
22		3.50	19.26
23		6.35	11.92
24		4.39	28.36

Table III gives a complete analysis of some of these waters, and shows that the brines carry carbonates and sulphates of the alkalis, the relative proportions being quite fortuitous.

TABLE III.
ULTIMATE ANALYSIS.

	Sample No. 15	12	16	13	23	24	20	18
K_2O	22.48	10.88	8.96	19.98	11.92	28.36	14.50	29.64
Na_2O	24.89	26.87	45.01	11.05	18.99	27.49	38.94	23.82
CO_2	11.82	2.21	29.65	2.80	22.01	20.06	28.40	15.91
HCO_3	6.29	1.39	7.91	3.40	4.98	7.56	12.13	9.20
SO_4	25.01	38.88	2.05	23.56	4.63	12.03	.44	17.30
NaCl	9.49	19.77	4.33*	39.20	37.55	3.97*	2.10*	2.73*
SO_3	....	....	2.07	....	....	.52	3.49	1.38
CONVENTIONAL COMBINATIONS								
K_2SO_4	41.63	20.12	4.46	36.98	22.10	27.07	1.03	32.80
K_2CO_3	....	....	9.41	....	....	20.83	20.39	13.73
Na_2CO_3	28.51	5.33	64.29	6.75	11.99	32.37	52.45	27.87
$NaHCO_3$	9.97	2.20	12.59	5.43	7.34	11.99	19.14	14.63
NaCl	9.49	19.77	7.18	39.20	37.55	6.55	3.46	4.58
Na_2SO_4	10.39	52.53	....	11.68	21.02	....	....	....
SO_3	....	....	2.07	....	....	.52	3.49	1.38
Tot. salts in % of water	10.61	9.54	8.31	7.86	6.35	4.39	3.70	3.43

*Cl.

The muds underlying the lakes have a corresponding variation, as is shown in Table IV. The alkali crusts

from partly or wholly dried-up basins are noted in Table V.

TABLE IV.

		Total Salts	K_2O Content in Salts
1	Jesse Lake	9.35	25.42
2	Lake near Reno	3.04	14.80
3	Lake near Lakeside	3.58	12.03
4	Sec. 1, T. 21 N., R. 46 W	3.47	13.20
5	Robinson Lake	.17	26.37
6	Broncho Lake	.18	21.81
7	School No. 126	1.53	27.79
8	Mayer Lake	.16	18.25
9	McCarthy Lake	.55	24.02
10	Hill Lake	.89	22.49

(Analyses 1 to 4, by U. S. Geol. Sur., Bull. 540, p. 466. Others by J. H. Show.)

TABLE V.

		Total Soluble Matter	K_2O Content Insoluble
1	Jesse Lake	34.06	21.00
2	Eight miles N. W. of Lakeside	4.62	6.16
3	Three and one-half miles E. of Reno	8.51	11.27
4	Crevath Lake	34.05	17.17
5	One mile N. W. of Lakeside	30.85	2.40
6	Jesse Lake	20.25	17.39
7	Cluff	8.97	29.70
8	One and one-half miles W. of Cluff	15.12	12.76

(Analyses by U. S. Geol. Sur., Bull. 540, p. 466.)

Origin of the Lakes

Prof. Victor Ziegler, of the Colorado School of Mines, and Edwin H. Barbour, State Geologist of Nebraska, are agreed upon the main facts as to the formation of the lakes and the origin of their potash content, and their explanations are endorsed by other investigators, albeit not unanimously. Prof. Ziegler says:*

> An examination of some of the lakes shows that they are underlain by a hard pan, buff to dark brown in color, and marly in nature. This serves as a basin and prevents the loss of water by seepage into the loose sands beneath (Fig. 2). In other cases, muds, rich in organic matter, which form the bottom of the lake, are apparently impervious enough to serve at least as temporary retainers for the water.
>
> From my observations I am inclined to believe that we can recognize distinct stages in the development of these lakes depending on the general age of the scoop basins in which they occur. When a basin is first formed, the drainage after rains or as a result of melting snow is quickly taken up by the porous sands on the floor of the valley. Of necessity such drainage carries into the valley a certain amount of finer sand and such silt as may be present on the hills. This, of course, serves as a packing for the interstices of the sands on the valley floor, making them less pervious. Succeeding inflows of water are not taken up as rapidly and are held for some time before dissipation. Thus intermittent ponds and alkali flats represent youth in the growth of such a lake. As this process continues the silt carried in makes the valley floor less and less pervious and allows the water to stand for longer and longer periods. Finally the point is reached where water is held through the whole season, at least in the deeper parts of the basin. Because of their shallowness, even these ponds and lakes will show great variation in areal extent. These permanent lakes and ponds represent a mature development. Combined wind and water deposition tends to fill these basins; hence the lakes, because of continued shallowing, will again pass through a period of intermittency, representing their old age, until they finally disappear.

It is easy to see how an intermittent lake without outlet will rapidly become "brackish," and Hance, in Bulletin 540 of the United States Geological Survey, calls attention to the fact that vegetable ash, resulting either from burning or from decomposition, contains potash as a far more important constituent than soda. This is especially true of grasses. In the case of these lakes, solubles may be concentrated by surface drainage, or by the light, fine ash blown into the basins by prevailing winds. Wind concentration is thought by some to be especially important, since the waters and muds of the lake bottoms appear to average somewhat higher in potash toward their eastern edges. This is very striking in some cases, notably Jesse Lake, where the eastern half has been dammed off and all pumping done from that portion.

*Colorado School of Mines Quarterly. The analyses in Tables II. to V. are also from this paper.

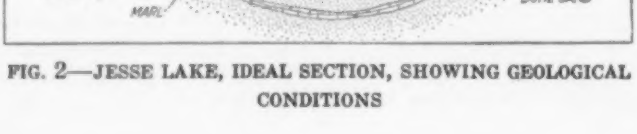


FIG. 2—JESSE LAKE, IDEAL SECTION, SHOWING GEOLOGICAL CONDITIONS

While the leaching of wood ashes may account for the superficial accumulation of salts, it fails to explain the local presence of more than one sheet of alkali ground water, separated by dry strata. While admitting that the origin of these waters is not yet definitely settled, some geologists who have spent much time in the area attribute the bulk of the potash content of the waters in the sands to the leaching of the considerable orthoclase feldspar contained not only in the superficial sands but in the underlying strata to a depth of several hundred feet. The decomposition products of such feldspars would form a water quite similar to the alkaline waters of this region, especially in carbonic oxide solution.

Early Work by Show and Modesitt

Mr. Edwin H. Barbour, State Geologist of Nebraska, has issued "A Preliminary Report on the Alkali Resources of Nebraska," in which he recounts the early development of the industry as follows:

> Messrs. John Show and Carl Modesitt recognized the commercial possibilities of these lakes, and to them belongs the credit of bringing the alkali industry in Nebraska to its present state. Their investigations began in 1910. In 1912 they filed mineral claims on Jesse Lake and the surrounding government lands, and erected an evaporating tower, a frame structure 32 ft. long, 24 ft. broad, and 4 ft. high. In the lower portion, gas engines, pumps a 20,000 gal. storage tank and the necessary machinery were installed. The upper half comprises a series of lattices, and some 20 floors over which the water was pumped at the rate of 300 gal. per minute. From a series of tests in November, 1912, the evaporation amounted to 1200 lb. an hour for a 10-hr day, on water containing 6 to 8 per cent total solids. The circulation continued until the concentration amounted to 10 or 12 per cent of solids. This "heavy liquor" was then transferred to an open tank and evaporated to dryness by direct heat.
>
> Since building this first simple plant many changes have taken place, and now (1915) the evaporating tower is used chiefly as a pumping and storage station. The "brine," which has a greenish yellow tint, was pumped directly from Jesse Lake through a 2½-in. pipe-line to Hoffland, a distance of three miles south, where it emptied into three steel storage tanks, one having a capacity of 10,000 gal. and two of 15,000 gal. From the tanks the "brine" flowed by gravity into concentrating vats or "cookers" each 16 ft. by 12 ft. by 5 ft. deep. When reduced to about 20 per cent solids it was pumped into steel finishing vats and brought to a 40 per cent solution.

The "cookers" were arranged in two sets, the first set of four being for preliminary concentration only. The solution is cascaded through these tanks, and heated by submerged steam coils. The crystallizing vats are also of steel, but have a false bottom of perforated steel plate. The crystals collect on this steel plate and when they build up to the level of the steam coils the latter are hoisted out, the mother liquor drained and returned to circuit, and the remaining slurry, con-

taining 30 to 40 per cent moisture, shoveled out by men in high rubber boots and loaded into box cars.

The method of producing salts from brines used by the company organized by Messrs. Show and Modesitt, "The Potash Products Company," in the latter part of 1916 is described as follows by Hoyt S. Gale in the United States Geological Survey publication on "Mineral Resources of the United States, 1916, Part II":

> The density of the brine from the pump is said to average about 9 to 10 deg. Bé. After passing to the plant through the pipe line it is heated and pumped through the solar tower in which it passes by gravity over wooden partitions, ranged one above the other like the slats of a window blind, and by this means somewhat concentrated by evaporation. It then passes to triple-effect evaporators—its density at this stage reaching about 30 deg. Bé. It then passes to a single-effect vacuum pan, where by crystallization of part of the salts its density is raised to about 48 deg. Bé. It is next passed to cooling and crystallizing vats, where, after standing a few days to permit crystallization of the salts, it is tapped off and returned to the system and the salts are shoveled out.
>
> The wet salts are dried in a rotary drum furnace, where most of the rest of the water is driven off, and are reduced to a dry, clinker-like mass carrying 27 to 28 per cent of potash salts and probably less than one per cent of moisture. The salts produced are mainly sulphates and carbonates.

This is shown by the following analysis, quoted by Mr. Gale, column 1 representing the dried residue obtained by direct evaporation of the lake water, and column 2 representing the material shipped as wet salts or slurry:

	1	2
Na_2O	21.0	17.5
K_2O	30.5	23.1
P_2O_5	0.2	0.2
Cl	1.4	1.0
SO_3	28.2	20.3
CO_2	17.3	12.9
HNO_3	0.3	2.1

The manner of handling the concentrated brine mentioned above has lately been superseded, and instead of using cooling and crystallizing vats they are boiling down the concentrated liquor in open pans, with steam coils raised 18 in. off the bottom. Crystallization is here continued until the salts reach the bottom of the coils, when they are finally dried in a rotating drum, as described later.

Pumping Plant at Jesse Lake

Inasmuch as the Potash Products Company, operating at Hoffland, eleven miles east of Alliance on the Chicago, Burlington & Quincy Railroad, was the pioneer in the field, it is natural that its organizers should pick out the best lake found in their explorations, which is called Jesse Lake, and which is probably the richest alkali lake in the whole region, having already produced several million dollars' worth of potash. After three years' operations, it is also natural that their practice in the recovery of lake waters should represent the furthest advance.

Jesse Lake is a body of water covering some 240 acres of ground, and is located about three miles north of Hoffland, in a flat, dune-surrounded basin entirely corresponding to the general description already given. At the present time (early in November, 1917), the water is only about 16 in. deep at the maximum, while high water represents a level some 6 in. higher. The pumpage, amounting to 10,000 to 11,000 gal. per 24 hours, is drawn from about 1500 wells, each sunk a distance of from 13 to 17 ft. to the top of the impervious marl layer underlying the lake bed (Fig. 2). The spacing of the wells naturally depends upon the texture of the sands—fine sands may demand holes as close as 10 ft., while the coarsest may allow an increase up to 25 ft.

The wells are drilled by hand from a small platform above the water-level in the following manner. An auger is worked down through the mud and sand until the sides of the hole start caving, when an 8-in. casing is set upright in the hole. This casing is merely a piece of gas pipe of suitable length, with the lower edge serrated with saw-teeth, 4 in. deep. Further sinking is effected by digging within the casing with a "sand bucket," working the casing down by rotating it with chain tongs. A sand bucket is merely a piece of 4-in. pipe, four or five ft. long, with a cutting point at the lower end (Fig. 3), the hole closed by a check valve. This is suspended by a bale from a piece of rope, and by means of a simple A-frame derrick is dropped through the casing, burying its cutting edge in the sand at the bottom of the hole. It is drawn up and dropped several times, and when full it is hauled out by hand and the contents dumped from the open top.

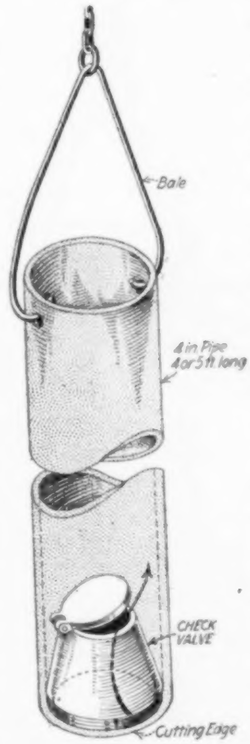


FIG. 3—SECTION OF SAND BUCKET

When the hole has reached the impervious hard-pan, a 1¼-in. "well point" is lowered to the bottom of the hole, surrounded by coarse sand, the casing withdrawn, and a new hole started. The well point is merely a piece of 1¼-in. pipe, plugged at the bottom. A short distance from the bottom the walls of the pipe are perforated (or a section of fine mesh screen set in) for entrance of the sand-free ground water. The well point is usually about 4 ft. long, the top bushed down to a ¾-in. pipe long enough to reach the surface of the lake, where it, together with forty or fifty others of like size, is connected through appropriate tees to a 2-in. pipe line leading to a pump.

There are three suction pumps mounted in small houses in the lake, collecting the brines from some 1500 wells and delivering to a fourth pump house on shore, where the entire pumpage (10,000 to 11,000 gal. per 24 hours) is forced through a 5-in. iron pipe line a distance of three miles south to the evaporating plant at Hoffland. The pumps are Deming & Gould plunger pumps, belt-connected to electric motors, ranging up to 25 hp. in size. An additional 6-in. wooden line is now under construction.

The varying grades of brine procurable from different locations in this lake are so marked that the Potash Products Company has built a dam entirely across the lake and is pumping water only from the eastern sands, replenishing surface water during the evaporating season by transferring from the larger western portion. The dam is quite a simple affair, as can

readily be imagined from the depth of water, and consists merely of two tight board fences with a little back-fill between.

Pumpage of Other Concerns

This description follows the general practice of the other operators of the district, differing, of course, in details. The Nebraska Potash Works Company, Fig. 4, with a plant at Antioch, four miles east of Hoffland, is pumping 800 tons of water per day through ten miles of 4-in. steel pipe, laid to a number of lakes in close vicinity of their works, while another company is engaged in the installation of a line of 6-in. wooden pipe leading 10½ miles southeast to Herman Lake, tapping several smaller ones en route, to furnish the Nebraska Potash Works Company with brine.

The American Potash Company, also with a plant at Antioch (Fig. 4), draws its water from a series of thirty-five lakes, largely located in a tract of land owned by John Krause some 12 to 14 miles north of the plant. This company has one wood pipe line, 6 in. in diameter and 14 miles long and one iron pipe line about 5 miles long, fed by eight pumping stations, each containing a duplicate installation of pumps with a capacity of 150 gal. per minute, driven by oil engines from 15 to 20 hp. This company pumps a large amount of surface water, and depends upon solar evaporation to a certain extent. For instance, their lake called Krause No. 1 has a very large area, 110 acres, and is but 6 in. deep. During the summer time the American company pumps water of desirable potash analysis testing only 3 deg. Bé. into this natural evaporating pan, and withdraws the same at the other end enriched to 17 deg. Bé. During the warm weather the water of this lake becomes too hot for wading, and the lake evaporated more water than the whole steam plant (1400 hp.). It seems reasonable to suppose that shallow wooden tanks with removable covers could be substituted by companies less favorably circumstanced, and enormous quantities of solar energy thus utilized. In fact, the American company intends to use solar evaporation as an auxiliary to its steam plant by building four concrete basins adjacent to their plant, each 100 ft. square and 5 ft. deep. These will be used as a combined brine storage and concentrator. In the summer time the brine will be pumped through atomizer sprays for evaporation, while in the winter nearly salt-free ice will be harvested.

The Hord Alkali Products Company, with a plant at Lakeside, 9 miles further east than Antioch (Fig. 5), is owned by men who own lands north and south of the Burlington railway to the extent of 100,000 acres. At present they are operating four pipe lines, from 4 to 8 in. in diameter and of a length up to 8 miles. All their present pumpage is from lakes to the north of their plant, but they own lakes on both sides of the railway, and eventually will be pumping a distance of 25 miles. Their operations are entirely confined to brines from sands, and they so arrange their pumpage that the water coming in averages close to a constant figure—about 5 per cent solids.

Evaporating Plant of the Nebraska Potash Works Company

At the outset it should be said that the present practice in Nebraska is merely to evaporate these alkali-bearing waters to dryness, so arranging the pumpage from various lakes that the resulting salts have as high a content of potash as possible. No effort is made to separate the soda from the potash, as the dry salts are shipped directly to fertilizer factories where it is used as such. A minimum of 14 per cent water-soluble K_2O is demanded by this trade, but the Nebraska producers have no trouble in shipping salts containing 20 to 30 per cent potash, for which they receive payment on the basis of potash content.

Consequently the potash works are merely evaporating plants, and all operate in the same manner, with minor variations in detail. Many of these variations are not the result of desire, but the necessity of taking the equipment which could be delivered in a reasonable time.

The Nebraska Potash Works Company's plants at Antioch may be taken to represent the standard evaporating practice of the field. Brief notes of their pumping plants have already been given. Mr. L. F. Hulen, president of the company, experimented on some leased lakes during the summer of 1916 by building a considerable number of solar pans of wooden floorings 12 ft. by 12 ft. by 8 in. deep. The lake water pumped into these boxes was sun-evaporated (Fig. 6), and at the end of his campaign he was enabled to ship 80 tons of cake containing 8 per cent of K_2O, which he marketed at a price of $3.50 per unit.

Following these experiments he proceeded with the

FIG. 4—PANORAMA OF ANTIOCH, NEB., FROM SOUTHEAST. RIGHT HAND, AMERICAN POTASH CO. CENTER, NEBRASKA POTASH WORKS CO.

FIG. 5—HORD ALKALI PRODUCTS CO. PLANT AT LAKESIDE, NEB.

FIG. 6—SOLAR PANS WITH POTASH CAKE

erection of the present plant of the Nebraska Potash Works Company, which evaporates some 800 tons of water per day, and which was first operated in May, 1917. The brine pumped in from the lakes is stored in two rectangular concrete reservoirs, 40 x 100 ft. and 65 x 175 ft., both 7 ft. deep. This brine is used for circulating water for condensing the steam drawn from the second effect of the evaporator, a centrifugal pump, direct-connected to an 1800-r.p.m. motor throwing 1000 gal. per minute for this service. The bulk of this warm brine is returned to the reservoir, where it is discharged and cooled by a system of sprays That part which is needed to feed the evaporators, however, is drawn through a smaller centrifugal pump similar to the condenser pump, and delivered to an Alberger heat interchanger, abstracting the heat from the exhaust from a steam engine which drives a 75-kw. generator furnishing power to pumps and other auxiliaries. From the heat interchanger the brine enters the first effect of a Swenson triple-effect evaporator. This vessel operates at an 8-in. vacuum and 208 deg. Fahr., and reduces the brine from its original specific gravity of 6 deg. Bé. to about 10 deg. Bé., when it is passed on to the second effect. This operates at 18 in. vacuum and 176 deg. Fahr., reducing the specific gravity further to 12 to 14 deg. Be., and finally into the third effect operating at 12 lb. pressure and 242 deg. Fahr. The live steam heating this vessel is here condensed and returned to the boiler as feed water. Since the liquor drawn from the third effect has a specific gravity of but 20 deg. Bé., it is then transferred to a "concentrator" or finishing pan which is merely another evaporator, acting as a single effect, and which delivers saturated brine to an 8-ft. diameter storage tank, 10 ft. high, at a concentration of from 30 to 35 deg. Bé., depending upon the composition of the salt. The evaporator and condenser room at this plant is shown in Fig. 7. This concentrator is at present blowing off large quantities of waste steam into the air, but a set of concentrating pans is now being erected for utilizing this heat, similar to the pans described in the early practice at Hoffland.

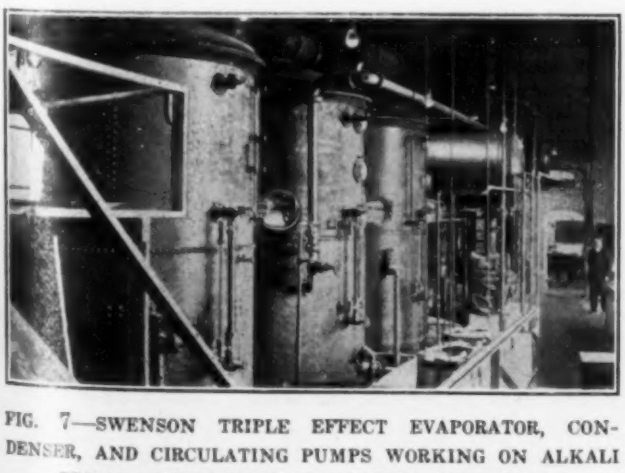


FIG. 7—SWENSON TRIPLE EFFECT EVAPORATOR, CONDENSER, AND CIRCULATING PUMPS WORKING ON ALKALI BRINE AT THE NEBRASKA POTASH WORKS CO.

The layout of the evaporating plants naturally varies considerably. At the Hord plant, where low-grade brine is evaporated, it is of course essential that the greatest care be taken to maintain their evaporating units at the highest efficiency. At this plant, where between four and five million pounds of water is evaporated daily, the owners have installed multiple-effect evaporators of four different styles—in fact, they put in any modern equipment which could be had quickly.

Drying the Saturated Brine

More variation is exhibited in the methods of drying saturated brine than in any other detail. The intermittent crystallization of the salts in steel pans has already been noted in the description of the early Hoffland practice, but this method was not only very wasteful of labor, but produced a salt containing a large percentage of water, which, of course, increased the freight charges without corresponding advantages.

Some style of rotary kiln (shaped after the fashion of the familiar cement kiln) is now almost exclusively used. These kilns are usually 42 in. in diameter and 45 ft. long, of unlined steel plate, containing numerous longitudinal angle-iron shelves riveted to their interior. The upper end of the kiln receives a stream of the concentrated brine through suitably controlled pipes, and the water is driven out as the material works its way down through the kiln. The kiln is heated by a large fuel-oil torch at the center of the lower end, which is partly stopped by a brick wall built to clear the end of the kiln. As the salts are thrown down they accumulate in small nodules, which are lifted by the angle iron shelves and repeatedly fall through the current of heated air—at the lower end actually falling through the flame itself. On reaching the lower end the nodules fall through slots in the kiln shell into a conveyor of some kind, whence they are delivered through a disintegrator to the storage bins and then sacked and loaded for shipment. The upper end of the kiln rotates within a round opening of a small dust chamber, discharging its gases through short stacks.

These kilns can produce about one ton of dried salt per hour. One difficulty with them is that the drying salt tends to stick and crust upon the inside of the kiln, requiring continuous and severe hammering to keep it loosened. In order to obviate this labor, wear and expense, the American Potash Company has replaced the angle-iron shelves by four lines of heavy chains, hung loosely at intervals. On passing the low point, these chains scrape the attached salts free and keep the interior of the kiln clean at all times.

The Nebraska Potash Works Company have devised a more efficient practice. They build a fire box at the upper end of the kiln, using an oil torch as before.

The brine is sprayed into the kiln at the same point, immediately ahead of the oil burner, through an atomizer set in the exact center of the kiln. In this way the finely divided brine is brought into immediate contact with the hottest oil flame, and drying is almost instantaneous. Only about one-third of the salt drops out the slots at the lower end of the kiln, however, and to reduce the dust losses to workable proportions, a baffled dust chamber has been built of brick some 15 feet long, 8 feet wide and 10 feet high, to receive the dust-laden gases blowing out the cool end of the kiln. A cyclone dust collector is also built into the flue before the gases finally are discharged into the air. With this arrangement practically no crushing of the salt is necessary, as it is recovered in a fine enough state to meet the demands of its fertilizer trade.

The Lakeside plant of the Hord Alkali Products Company, on the other hand, uses an original patented process consisting of a regular brick-lined cement kiln 6 feet in diameter and 50 feet long, running the temperature at a sufficient point that the product delivered at the lower end is well clinkered. This hot clinker is immediately delivered to the upper end of a small rotary cooling kiln, 3 ft. 6 in. in diameter and 25 ft. in length, placed alongside, and there sprayed with saturated brine. The heat of the clinker not only evaporates a very considerable amount of liquor, but is itself granulated by the cold liquid, the product requiring no more crushing than that of the other kilns. The output of this kiln is 150 per cent higher than those previously described.

In all cases the dust losses are considerable, as is evidenced by the billowy white smoke rolling from the kiln stacks when in operation. While a large portion of this could easily be recovered by modern treater plants, the sentiment of the managers seems to be that they would rather devote their energy to the crowding through of tons of production, rather than the saving of hundreds of pounds of waste. It is too bad that both cannot be prosecuted simultaneously, as they are both factors leading to the same object.

Canada Extends Embargo on Iron and Steel Exports.—A more complete embargo on the exportation of iron and steel products is established by a Canadian order in council of Nov. 15, published as Customs Memorandum No. 2138B. The following articles are placed under prohibition of exportation to all destinations abroad other than the United Kingdom. British possessions and protectorates: Pig iron, steel ingots, billets, blooms, bars, and slabs, iron and steel plates, iron and steel shapes (comprising beams, channels, angles, tees, and zees), iron and steel fabricated for structural work and shipbuilding.

Short Course in Ceramic Engineering.—The University of Illinois Short Course in Ceramic Engineering, will be given Jan. 7-19, 1918. The course will be under the direction of Prof. E. W. Washburn, head of the Department of Ceramic Engineering, and Mr. A. V. Bleininger, Ceramic Chemist of the National Bureau of Standards, assisted by Professors C. W. Parmelee and R. K. Hursh of Illinois, and a corps of lecturers on special topics. The two weeks' course is intended to cover in an elementary and practical manner the scientific principles underlying the practice of clayworking.

Engineers in Training

By Robert Tudor Hill

Professor of Economics and Sociology, Union College

"Liberalizing the classics" has been a favorite pastime inside and outside of educational circles. Early specialization and training in scientific and particularly engineering and other vocational technique has been much in vogue. But for some time, hastened by the war, a desire to "liberalize technical education" has been evident. An increasing number of educators and trainers, industrial and engineering leaders are sensitive to changing conditions and needs in the general business and industrial world. As a result proposals to readjust technical education are much in order.

The narrow technician is as much handicapped for best service as the broad Jack-of-all-Trades who knows a little about everything but nothing very well. This is peculiarly true for engineers who more and more must be concerned with large public problems of finance, governmental administration, policies respecting public utilities, commercial policies, transportation and so on; also industrial problems of management, production costs, labor turn-over, methods of industrial remuneration, marketing, corporation organization and finance.

Engineer's Interest in Politics

"The engineer has always been knowingly or unknowingly interested in economics but has let politics severely alone. The engineer of the future, however, must take an active interest in both subjects." This is the way in which Mr. E. W. Rice, Jr., president of the General Electric Company, before a recent meeting of engineers, began some suggestions concerning desirable changes in technical educational procedure.

New demands upon industrial leaders who are to be trained for leadership must be met by educational programs adjusted to meet needs. The suitable training and equipment of young men who later on are to have large administrative responsibilities is a matter of considerable importance. Impelling social and industrial needs require suitable modifications, changes or additions to educational practice. Of even large importance, perhaps, is the duty placed upon educational leaders and institutions to sense out changing conditions and needs and to adopt "point of view" and educational effort to these changes. But with difficulty can they do this alone; they should have the active support and co-operation of those who, in an advisory capacity, perhaps, can help them make educational programs and methods most effective. Education must be for life, and those closest in contact with it should be able to contribute richly from experience.

Most of the large engineering problems, aside from those of pure technique, center around economics. This is suggested by recent investigations of the Carnegie Institute of Teaching. Problems of management, production costs, business and industrial finance, labor and so on are those around which the wheels of industry turn. The necessity of increased emphasis upon economic studies in engineering schools and more and more effective instruction in these subjects is easily apparent.

The more light we have on the matter and from as many angles as possible the better. The results of an inquiry made among 152 engineering students in five different classes during five successive years, in Union College, are interesting and suggestive.

Choice of Vocation

The question of vocational direction is important, not only for engineers, but for all students. Table I, drawn from answers to the question, "For what vocation are you preparing?" presents at the outset a situation which, if general, is a challenge to educational leaders. Added importance comes from the fact that these students were all seniors, the majority over 21 years old, and almost all in electrical engineering.

TABLE I—VOCATIONAL CHOICE

Class	Number in Class	Decided	Undecided	Technical *Engineering	Other Fields
1914	39	24	14	33	6
1915	15	11	4	11	4
1916	33	23	10	30	2
1917	38	21	16	30	8
1918	27	17	10	22	3
Total	152	96	54	126	23
Per cent of total	..	63.1	35.5	82.9	15.1

*Includes both decided and undecided vocations and indicates possibilities.

Note—In each table will be found small discrepancies due to incomplete replies. The same questions were asked each year.

These figures sustain the general impression as to vocational uncertainty secured from personal conferences with students. Young men do not follow in their fathers' footsteps, and many do not, during their years of training, plan out their own. For many, vocational plans even during vocational study are of incidental importance. Consequently vocational direction after schooling is most uncertain.

From available information concerning present vocations of eighty-seven of these same students it has been found that thirty-two are now engaged in work of their college vocational choice; eleven are now in work related somewhat directly to their college vocational choice, and seventeen are now in work altogether different from their specialized college studies and not related to their college vocational choice.

This much uncertainty and vocational indefiniteness causes much waste of time and effort of both student and instructor, apart from financial losses. Later on the man, personally, loses from whatever inefficiency this entails and business and industry pay the price. Expensive labor turn-over begins back in the colleges and secondary schools.

Some kind of suitable vocational guidance, advice and direction is desirable. Definite life purposes are more needed among college and technical men. It is reasonable to expect technical students, at least, to know what their training is for. The value of their training, then, would be greatly enhanced and weaker students of vocational uncertainty would be eliminated or directed into more suitable vocations in accordance with interest and capacity.

Slight Interest in Management and Business

Answers to the question "In what phase of engineering are you most interested?", tabulated in Table II, suggest something of the wasted time of young men in technical training, at least during ordinary times, as well as the uncertainty of vocational choice upon graduation. But a more important problem is involved. Technical students are expected to be interested chiefly in the technical aspects of their work. But newer demands of business and industry on the non-technical end of things should be brought to the attention of technical students. In some way they should learn of the quickened demand for able administrative and executive work in engineering and industry, and should be given an opportunity to prepare for such service. War conditions show up a peculiar national weakness which far-sighted leaders have realized for some time. Most emphasis in the business and industrial world has been placed upon machinery and materials. Important as these are, changing conditions and needs increasingly emphasize the human factor in industry. Management of men is as important as the design of machinery. Industry is rapidly moving into a new period of "human technique." The signs of the times are unmistakable.

TABLE II—ENGINEERING INTERESTS

Class	Number in Class	Technical	Management and Business	Uncertain
1914	39	32	4	3
1915	15	12	1	1
1916	33	23	4	3
1917	38	27	8	1
1918	27	15	2	10
Total	152	109	19	18
Per cent of total	..	71.7	12.5	11.8

For best service in this field men must be as carefully trained as for more limited technical work. A new kind of training must be added to the old. New points of view must be given to the younger men, and new visions of large industrial service. While in training young men should have the opportunity to put in broad foundations for future service in both technical and non-technical administrative fields. Technical training may well be "humanized" and a large infusion of general training added, particularly in economics, government administration, history and philosophy.

The lack of information among college and technical school students, and even graduates, concerning vitally important industrial, social and political problems is striking. To immaturity is frequently added lack of interest, but this is due largely to lack of opportunity or incentive. In any case, the situation is unfortunate and ought to be remedied. A "social consciousness" is more and more needed among men of responsibility and affairs. It should be developed purposely among men trained for largest service.

Dearth of Study and Reading in Economics

The question, "What kind of economic reading, if any, have you done previous to this year?" appears to have been answered frankly. The result is given in Table III.

TABLE III—READING AND STUDY

Class	Number in Class	Previous Study*	Some Reading	Little Reading	No Reading
1914	39	1	3	8	20
1915	15	1	2	1	11
1916	33	3	3	8	19
1917	38	3	8	2	24
1916	27	2	1	4	20
Total	152	10	17	23	94
Per cent of total	..	6.5	11.2	15.1	61.2

*In High School or College.

Is this a typical state of affairs among American college men to-day? If so, can it be corrected? Or are men in technical training particularly limited in their reading and thinking? There is much unconscious absorption of ideas touching the important problems of labor, industrial organization, finance, agriculture, business management, investments, markets, the social unrest, Socialism, and so on but little definite and directed thinking. Immediately upon graduation most

college men are projected headlong into the midst of an industrial, business and social system which is of utmost consequence to them. But more than 90 per cent of the boys of the country never go beyond the second year of high school, where the lack of suitable civic, vocational, social and industrial training is notorious. Thus the vast majority of men are deprived of a training during youth and early manhood which has most direct, practical value besides a civic utility.

It is unfortunate that special encouragement and assistance for such life needs should be deferred until the upper-class college years. It is doubly unfortunate when a technical school, for instance, provides no opportunity at all for study and training in political science, economics, administration and government. Some technical school curricula can be severely criticized for such omissions, and altogether too many young engineers, chemists, physicists and other technical workers are thrown into an industrial world whose character, history, organization, purposes and problems are not even appreciated, much less understood.

Nevertheless, students to-day are much more sensitive to many questions of interest and importance outside specialized technical fields than they realize. And the nearer schools are brought into contact with real life and actual conditions and needs, the more vitally will such interests be quickened. The selection by these 152 students of economic topics of special interest, irrespective of information concerning them, is suggestive. The items are given in Table IV.

TABLE IV—SELECTED ECONOMIC TOPICS OF INTEREST

Class	Number in Class	Industrial Organization and Management	Labor Problems	Finance	Social Problems	Public Questions	Domestic and Personal Problems	Business
1914	39	5	13	4	6	23	11	5
1915	15	3	13	5	3	4	2	..
1916	33	..	17	3	3	12	2	3
1917	38	4	15	6	1	10	3	4
1918	27	4	14	8	4	5	2	6
Totals. ..	152	16	72	26	17	54	20	18
P.c. totals .	*	7.2	32.3	11.7	7.6	24.2	9.0	8.0

*Replies received numbered 223. Percentages are computed on this base.

The importance attached to these several topics by technical students is both interesting and instructive. The selection, in fact, is a challenge to business men, industrial leaders and to those engaged in active political life; it is doubly so to the teacher who seeks to make education a vital force for national efficiency.

Technical Courses Heavily Loaded

Technical curricula and courses generally are so loaded with desirable and apparently necessary technical studies that, with time available, much liberty in choice of subjects within or outside the courses themselves, has seemed impossible. Unfortunately, however, such limitations narrow the training seriously. Men are turned out as fairly good mathematicians, electricians, engineers, helpers, instrument men, chemists, designers, draftsmen, and so on, but for largest service in positions of modest executive responsibility they are materially handicapped. Some students feel this state of affairs when they are finishing their technical studies, and if not too much warped would be glad to "broaden out" if possible. Generally, however, this feeling comes on some time after graduation, when actual experience outside the classroom and laboratory makes them more appreciative of the non-technical problems of their chosen vocation.

It is possible that from a sense of politeness or consideration the factor of error should be applied to a study of answers secured from the question: "Would you have elected economics if optional?" (Irrespective of the instructor.) Four per cent of the students did not venture an answer. Seventy per cent voted yes, 13.8 per cent, no, and 11.8 per cent were uncertain. About half othem thought that probably they could "uick up" something useful or interesting in the course of study—a one-semester course; about one-fourth of the students had special interests upon which they wanted more information; about one-fifth had no particular reasons, either general or specific, why they should carry the course; the others had no answer at all to the question: "What do you hope to gain from this study?" These might be represented by the fellow who said: "A passing grade."

Conclusions

Some tentative conclusions may be drawn from this modest study and from a few observations made elsewhere.

1. Increasingly important problems in the fields of industry, business and public service are economic in nature. Efficient service in any field requires suitable training. Most emphasis must be placed upon economic study for such service.

2. Engineering and technical education is peculiarly suitable for business and industrial leadership. But such training must be more than technical.

3. Non-technical training, however, must fit in with real conditions and needs. It should also be adopted to the peculiar needs of technical students.

4. To broaden out technical courses some technical work will be modified or discarded; or, such courses must be lengthened at either or both ends.

5. Readjustments in preparatory and earlier secondary-school training are desirable so that preliminary training may be completed earlier. This will save time below and gain time above.

6. Suitable vocational advice, guidance and direction may be introduced to save time and avoid waste effort.

7. Limited "point of view" must not be sacrificed to "breadth of view" at the behest of immediate technical demands. Technical as well as so-called cultural education must be for life and service.

8. Non-technical instruction for technical students must be as efficient as technical instruction. Teachers through their own training and experience must be able to relate their non-technical teaching to definitely discovered conditions and needs of the technical world itself.

Schenectady, N. Y.

The solubility of **pure radium sulphate** in water in different concentrations of sulphuric acid and in sodium sulphate solution has been determined by the United States Bureau of Mines in connection with its technologic investigations on carnotite ore. This work has a definite commercial application, giving important information on the best conditions for precipitating the radium from solution.

Utilization of Manganese Ores in Sweden*

By Joh. Harden.

The importance of manganese in the steel industry is so well known that it would be idle to enter upon its merits in that respect and may be considered to be outside of the scope of this paper. It is sufficient to repeat a well-known Sheffield expression, saying: "Manganese is about the best tonic for a poor steel." Of course, it is to be borne in mind that for some purposes manganese must be avoided; nevertheless, the expression holds good in many cases.

Sir Robert Hatfield in Sheffield has no doubt expanded our knowledge on this subject more than anybody else, especially as regards its physical influence upon steel. The enormous number of tests carried out under his direction are far too many to be referred to here. They are recorded in the Proceedings of the Iron and Steel Institute, METALLURGICAL AND CHEMICAL ENGINEERING, and elsewhere, and may be available for those interested.

Our main question is: Can we supply our own need of this useful agent from our own sources? Also, in what way is the metal to be handled to obtain the best economy possible?

Looking over the records of a *normal* year of consumption, such as 1913, the import to Sweden was, according to the Government reports, during the year around 5000 tons ferromanganese and spiegeliron, at a commercial value of 961,516 Swedish crown (about £48,000, or $232,800), while the home consumption during the year 1916 was about 5500 tons, equal to around 4000 tons pure manganese, besides silicomanganese corresponding to about 2000 tons pure manganese.

During the year 1915, according to the same reports, the country produced 7607 tons manganese ore, valued nominally to 320,760 Swedish crowns (about £16,000, or $77,600). The present requirement of the country, for home use only, is about 4000 tons manganese, of which one-half may be in the form of silicomanganese.

As to the ore fields, only three seem to be of any importance at present, viz., the Spexeryd district, carrying an ore of about 45 per cent Mn.; the Longban district, with an ore of some 34 per cent Mn. (as well as some tailings and concentrates, with about 28 per cent ore, some of which is used for the manufacture of colored glass bottles), and, finally, the Bolet and Dalsland district, which although being worked has not so far come into prominence. The same may be said of several smaller fields distributed over the country but of less importance, as most of them contain chiefly iron ore high in manganese.

Of these districts, the Spexeryd is the most advanced, yielding, without spoiling the streaks, at least 6000 to 7000 tons of ore per annum, if required.

If at present about 2000 tons ferromanganese and, say, 3500 to 4000 tons silicomanganese are being produced in the country, these factories are so equipped that they can increase their capacity to at least 8000 tons per annum.

One of the factories, the Vargön Co., possesses a power capacity of some 15,000 hp., and the other, the Ferroalloy Co. at Trollhättan, has some 3000 hp. These power capacities are of course not at present used for the production of manganese only, but various other alloys and materials, but may in course of demand be made available for the increase; hence the possibility exists to provide the country with its requirement of these materials from independent sources.

As to export to other countries, the lack of tonnage is of course a serious objection. Besides, the rich deposits of Mysore and Bangalore as well as those of the United States, and the low coal prices in England and the United States may prevent any extensive export. At present a total export prohibition to any foreign country is strictly levied by the government so as to secure the home demand.

Methods of Smelting

For the production of ferromanganese the ores pyrolusite, MnO_2, and manganese spar, $MnCO_3$, are the chief materials. Pyrolusite has theoretically up to 63 per cent of Mn, and the spar 61.72 per cent MnO. Other ores, such as braunite, Mn_2O_3, hausmannite, Mn_3O_4, psilomelane, MnO_2, and rhodonite, $MnSio_3$, are used with advantage. In some cases even manganese-rich slags are being used.

Before the introduction of electric furnaces on a larger scale, it was practice to smelt the manganese ore together with charcoal and iron ore in blast furnaces. In this manner spiegeliron was obtained, containing from 5 to 20 per cent Mn. Even at present a considerable quantity of high-percentage ferromanganese is being produced in the blast furnace, especially in England and America. The loss of manganese, however, is very high owing to the fact that the metal and its compounds are very volatile at high temperatures and a great deal is carried away mechanically by the blast, also a good deal of re-oxidation is unavoidable.

It is on account of these facts that the electric smelting method has been widely adopted and may under otherwise suitable conditions supersede the old method. This holds true especially in such countries as Sweden, where the supply of ore is rather limited and charcoal is becoming more and more expensive every year; wherefor the greatest economy with both is called for. The cost of power is, on the other hand, comparatively low, since power may be had for something like £2 ($9.70) per hp.-yr. or less, when taken in bulk, and this feature alone would almost be sufficient for a decision in favor of the electric furnace.

In addition to this stands the fact that the material produced in the blast furnace has always a very high carbon percentage, as a rule from 8 to 12 per cent, and a higher carbon content always calls for a lower price on the market. It is true that a lower percentage of carbon also may be produced by careful handling in the shaft furnace, but in that case the losses are prohibitive, while in the electric furnace a product with lower carbon can be made at will without any excessive loss of material.

In practice also, a considerable quantity of manganese alloys other than ferro are in demand, and these are hardly to be produced economically, if at all, except in the electric furnace.

Furnace Types

As to furnaces, either single-phase furnaces with conductive hearth or three-phase furnaces with or without the neutral point at the bottom may be equally ad-

*A paper read before the Fifth General Meeeting of Chemists in Sweden, June 6, 1917.

vantageously used. When working on a large scale, the latter type, with the neutral point under the hearth, seems, however, to be mostly preferred for many reasons. The electrodes become smaller, the heat-distribution in the furnace is more uniform and the power regulation more even; also the tapping is less troublesome.

It is fortunate that ferromanganese has a comparably low smelting point, from 1250 to 1375° C. (depending on the grade), wherefore it may, contrary to ferrotungsten, for example, be easily drawn off into molds, and is hence more easily broken up.

The furnace is charged with the proper mixture of ore, coal and flux at regular intervals; iron in suitable proportions is added as the ore requires. The iron should be added as *scrap* and not, as was formerly the practice, as ore, since the reduction of the iron ore is consuming a good deal of power and may be more cheaply produced in the coke-furnace; besides, the iron ore is apt to upset the run of the furnace and is therefore more uneconomical. Finally, the separation of the manganese from the slag takes place much more readily if the iron is added in the metallic state than if ore is added; hence a greater saving in material.

Lime, quartz, etc., also are to be added as the individual ores require to insure good working.

The consumption of power is dependent on the following three factors, namely: The size of the furnace, the proper handling of the charge and operations, and, finally, on the desired percentage of carbon and silicon.

As a basis for estimation, however, we may assume that a furnace with a capacity of, say, 3000 kw., three-phase, properly managed, should not consume more than 8000 to 8500 kw.-hr. per ton ferromanganese under normal conditions.

The furnace should be worked so that *no open arc* will occur. If this is not avoided great losses and a higher power consumption per ton will result. The charge must be kept so high in the furnace that the actual working zone is fully covered and the incandescent part of the electrodes nearly buried. The tappings must be timed with great care, and overheating of the metal must be studiously avoided. Any mistake in these directions will unavoidably result in bad economy.

The manganese easily forms double carbides of Mn-Fe and C. The manganese carbide proper, CMn_3, holds theoretically 6.77 per cent C and 93.23 per cent Mn. Ferromanganese, as produced in the electric furnace, will as a rule hold about 6 to 8 or 10.5 per cent carbon, depending on the manner of working. A typical analysis of the market product is:

	Per Cent
Mn	80 60
Fe	11.93
C	6.41
Si	0.65
P	0.08
S	0 026

A low content of silicon is always desirable. A much lower percentage than the one given above, down to 2 per cent and even under 1 per cent, *can* be obtained with adequate working of the furnace. Should such a low carbon be called for, it will as a rule be found much too uneconomical to produce it in one operation, but far better to refine the product in a subsequent treatment. This operation is a rather difficult one and of course necessitates a larger power expenditure; hence the higher price for such material.

In the case of silicomanganese a suitable quantity of quartz is added to the charge, reckoning with the amount of silicon which is usually volatilized as well. The finished product holds generally about 70 per cent Mn, 18 to 20 per cent Si and 6 per cent C.

A few special steels require an alloy particularly high in manganese, up to 98 or 99 per cent. Such material usually is produced by the thermit process, where finely divided aluminium is used as a reducer. In this way an alloy very high in manganese and low in carbon is obtained, but the product is also very expensive, on account of the high price of the aluminium. Also, although the method is very simple, it cannot be used on a large scale, as is obvious.

It is also possible to produce pure manganese by means of electrolysis of the molten oxide in a fluorspar bath. According to G. Gin in France, only 3475 kw.-hr. per ton manganese would be required.

All such methods, however, have only a curiosity value compared with thermic smelting and probably will never be used earnestly on account of low production figure and high cost of plant.

Methods of Using the Alloy

There is no doubt that up to recent times several mistakes were made when the alloy was to be added to molten open-hearth or Bessemer steel, especially when material high in manganese was to be made. If added direct in the Bessemer converter, the primary effect of deoxidation is certainly obtained, but during the subsequent finish blowing most of the free manganese will burn away or get lost, and the desired content in the steel will be very problematical.

If added direct in the open-hearth furnace, an uncertain quantity will at once enter the slag, and in each case an unavoidable loss of manganese will result.

When this was recognized, the practice changed to the addition of the alloy in a crushed state, preheated sometimes, but still solid, into the ladle just after pouring. That method is still very much in use.

The consequence of this practice is, as a rule, that the ferromanganese will not, in spite of rigorous stirring, mix and *alloy* properly to its whole content with the liquid mass of steel in the ladle, but single particles will remain partly in a semi-fused state, whirling round in the mass, leaving behind a trail much like a comet's tail of manganese.

If such an ingot is cut in two lengthwise after it has cooled, it will be observed that these lumps form light spots, more or less prominent, as hard lenses in the steel. If the ingot is rolled out, these lenses elongate forming the well-known "ghost lines," so called since they sometimes disappear and again turn up elsewhere.

Such ghost lines are, as so often recognized, very detrimental to the steel, especially for the milling or drilling. They are much harder than the surrounding part, which will cause the milling tool to make a deviation from the true cut, or else will ruin the edge of the tool in a short time. It has occurred more than once that a large delivery of otherwise excellent ware had to be rejected in bulk, and analysis of the spots has invariably shown that inferior alloying was the cause. Such occurrences are not apt to add to the credit of the firm

apart from the economical losses in the direct way; in fact, it has recently brought about a costly lawsuit, in which the maker lost the case, as a matter of course.

The only correct way to avoid any such result is, therefore, to add the ferro in a *liquid state* at the *right moment* direct into the liquid steel in the ladle and stir properly. This, of course, does not pertain to crucible steel, where the alloying takes place under entirely different conditions.

The above fact was also clearly recognized in time by the more advanced steel makers, although the old method is still used in places. The question then arose, how to proceed to add the alloy in the molten state in the best way.

Superiority of Electric Furnace

The electric furnace was then adopted as being considered the best melting device for that purpose. For instance, at Messrs. Roechling works, where the author had several opportunities to follow the process closely as to economy and utility, the pig iron was drawn direct from the blast furnace and taken direct into the Bessemer converter, where it was blown down in about seven minutes. It was then tapped into a ladle, the right amount of ferromanganese, previously melted in a suitable electric furnace, was added, and a part of the charge was brought into an induction furnace and finished off as high-grade steel, while another part was treated elsewhere into a lower grade of steel for rails, etc.

As this procedure was repeated as often as every other hour and about 120 to 140 lb. of ferro was added each time, it was necessary to provide for a suitable stock furnace for molten ferro only, which was always ready to deliver the adequate quantity of metal required.

A furnace specially suited for this purpose must be so designed that a very even supply of heat is provided, without the danger of accidental overheating or breakdown, which would lead to loss of material and disturbance of the whole series of subsequent operations. Oil furnaces have been used for the purpose with success, but, in Scandinavia especially, their demand on oil cannot be met, for obvious reasons. Besides, the oil furnace requires wind, and in excess, too, in order to obtain the temperature required, which will lead to oxidation of a part of the metal.

The electric furnace is, therefore, especially in the countries mentioned, the most appropriate heating device, particularly if worked with indirect arc, or better still as induction furnace. The latter type is doubtless more economical as far as heat-efficiency goes, although the lining question may be more difficult to handle, inasmuch as the manganese, as is well known, possesses special cutting properties on linings. This difficulty can be satisfactorily solved, however, by the choice of right material and proper handling.

Messrs. Roechling were using either a normal three-phase induction furnace or else a resistance furnace of a special design, which gave very good results, particularly the first mentioned. At another works a furnace with submerged arcs, somewhat similar to the Hèroult furnace, but with three carbons (the Nathusius type), was used in another instance to be related here, which also worked satisfactorily.

Some of the figures given herewith are taken from *Stahl und Eisen* and others are the author's own observations on the spot.

The furnaces in question had a capacity of 3 tons and $1\frac{1}{2}$ tons respectively, which in the former case was too large, but, as the result shows, the efficiency did not suffer much on that account.

The power capacity was about 300 kw. when melting and 120 kw. for maintaining the heat after liquifying.

Heat Balance and Thermal Efficiency

In order to obtain reliable figures of the heat balance, the actual or specific heat of ferromanganese was first determined. For this purpose, a material containing 80.6 per cent Mn, 11.93 per cent Fe and 6.41 per cent C was very carefully melted and exact readings taken under proper conditions. The results of these observations are given in Tables I and III.

TABLE I—SPECIFIC HEAT OF FE-MN

Temperature C°	Average Spec. Heat	Calories Represented by 1 Gr. Fe-Mn
600	0.1625	97.5
700	0.1667	116.7
800	0.1711	136.8
900	0.1763	158.6
1000	0.1822	182.2
1060	0.1863	197.4
1200	0.2133	255.9
1258	0.2225	280.0
1340	0.2268	304.0

TABLE II—HEAT-BALANCE PER TON FE-MN

Heat Supplied	Kw.-hr.	Per Cent	Heat Expenditure	Kw.-hr.	Per Cent
Electric energy supplied	833	100	Remelting heat	354.0	42.5
			Melting of the slag	7.4	0.9
	833	100	Losses		
			Transformer	33.3	4.0
			Leads	58.3	7.0
			Cooling water	50.0	6.0
			Radiation and conversion losses	330.0	39.6
				833	100

From the tables it will be seen that the thermal efficiency was only 43.4 of the heat supplied. This is probably to be accounted for by the fact that the furnace was too big (3 tons) for the charge and also that the time between rechargings was rather long.

This balance refers to the arc furnace. The corresponding figure for the induction furnace with a capacity of 700 to 750 kg. was 63.2 per cent, the conditions in that case being more favorable generally, as the charging could be done quicker and the heat insulation could be more effective. Also the losses in the leads, which are a heavy item, were eliminated. The charge was in both cases kept at a temperature of about 1350° C., which is somewhat too high, but was necessary on account of the distance over which the metal must be carried.

Should a furnace be erected solely for this purpose, there is no doubt that it could be arranged so as to work with greatest economy, if all other uses were to be excluded.

Cost of Operation

The cost of operating the arc furnace for ferromanganese is given as follows. (The power cost was in round figures 0.02 of a shilling per kw.-hr.)

Cost Per Ton Fe-Mn	Shillings	Dollars
Power: 833 kw.-hr. @ 0.02 sh	16.66	4.00
Electrodes @ 35 sh. per 100 kg	1.90	.46
Labor costs	1.65	.40
Linings and repairs	0.65	.15
	20.86	5.01

Or, in round figures, £1 10d ($5) per ton ferromanganese.

This does not include the heat for the preliminary heating-up; while this by continuous working would throw the balance out of proportions, of course a small amount should always be added on this account, depending on the length of the campaign.

The corresponding figures for the induction or resistance furnace show about the same result, or a little lower, namely 19s. 3d. ($4.68) per ton. As the electrode item is eliminated the costs should be less, but the maintenance of the lining costs a little more, hence the smaller difference in the sum total.

The heating-up of the arc furnace after shut-downs and repairs costs as follows:

	Shillings
Power: 630 kw.-hr. @ 0.02 sh	12.60
Coke and electrodes	5.50
Labor	2.10
	20.20

Or just over £1 ($4.85).

The heating up of the induction furnace cost 17s. 6d. ($4.20).

The loss of manganese was in both cases very slight, or 0.385 per cent in the electrode and 0.360 per cent in the induction furnace, consequently of no practical account and need not be considered.

Comparative tests were also made to ascertain the advantage between the addition of molten ferromanganese and such added in solid, but pre-heated in oven.

The result was as follows:

	Molten Ferro-Manganese					Solid Preheated Fe-Mn			
Date	Ingot Weight, Kg.	Actual Mn Used Kg.	Actual Mn Used %	Calculated Mn Kg.	Calculated Mn %	Ingot Weight, Kg.	Mn Used Kg.	Mn Used %	Saving in Mn Added Liquid, %
31/1	19,160	120	0.61	129	0.67	498,860	4,980	1.00	33
1/2	86,990	350	0.40	522	0.60	341,510	3,700	1.08	44
3/2	67,330	280	0.42	355	0.53	397,590	4,220	1.06	50
4/2	62,290	290	0.46	347	0.55	343,270	3,710	1.08	51
								Average saving:	44.3%

If the ferromanganese is taken at the old price per ton, 204s. ($49) per short ton, the costs and savings work out as follows:

	Shillings	Dollars
Fe-Mn added solid	31,221.82	7,493
Fe-Mn added liquid	24,471.41	5,873
Sum total saved	6,750.41	1,620

Or, in other words, by producing 19,827 tons ingots, a saving of £337 1s. 6d., or, in round figures, 4½d. ($0.09) per ton ingot.

This shows that an actual saving in material is the direct result of liquid addition, a fact which speaks for itself when large quantities are to be handled, especially now, as the price of ferromanganese is nearly five times higher than normal. A good brand, with a carbon of 5.5 per cent and low in silicon, is now costing even up to £75 ($365) per ton, while silicomanganese costs about £45 ($220) per ton, which should tell very markedly if a saving of something like 44 per cent is made when added liquid.

In addition to this comes the fact of superior finished material, free from "ghost lines" and hard lenses. If this is rightly taken into account a secondary saving of great importance is made as well, which is not to be neglected since a rejected delivery may cost the works more than the value of the entire material in question.

Finally, the time-saving element should not be overlooked; if ready liquid alloy is really at hand, it is obvious that the finishing off of a charge goes much more rapidly and surely than if solid stuff is to be added, and this is of no mean importance to the total efficiency of the plant.

Taken in all, it seems as if the electric furnace has one of its largest fields in this direction at present, as no other melting device is so adaptable to this task and the immediate result is sure and certain. Of course, the prejudice of works managers and workmen alike must first be overcome, and, we fear, this is the most difficult side of it. It is much easier to design a serviceable furnace than to persuade folk to use it and to handle it properly.

Stockholm, September, 1917.

Some Notes on Fusion Apparatus

By Frederick Pope

Fusions involve widely differing apparatus, varying from the ordinary cast-iron, hemispherical kettle shown in Fig. 1 to the cast-steel autoclave as shown in Fig. 2, or to the wrought-iron steam-jacketed vessel as shown in Fig. 3.

Perhaps the most common type of kettle used for alkaline fusions is that shown in Fig. 1. This kettle has numerous modifications. It is made approximately hemispherical, as shown in Fig. 1, with a curving bottom and sloping sides, as shown in Fig. 6, or the deep form, as shown in Fig. 4.

In kettles of this class the cone type of agitator is seldom if ever used. The propeller type of agitator is used rarely, and, when used, for special work. The agitator is usually some modification of the horseshoe type, either a plain horseshoe or a horseshoe with the blades deflected to give vertical as well as horizontal impetus, as shown in Figs. 1 and 7; or it may be provided with a number of blades working against break-

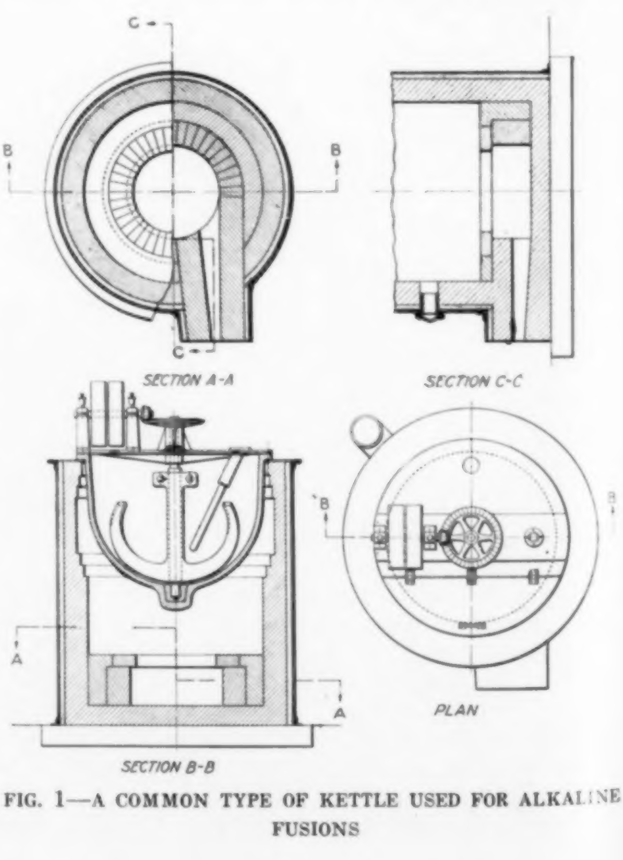


FIG. 1—A COMMON TYPE OF KETTLE USED FOR ALKALINE FUSIONS

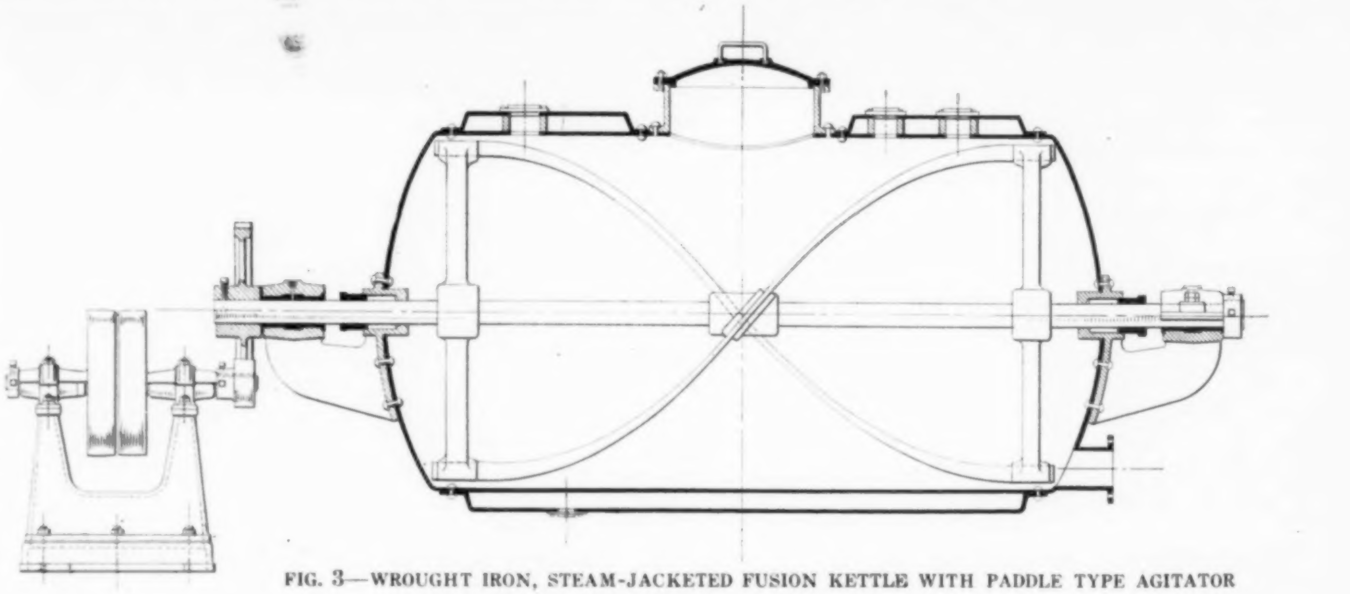


FIG. 3—WROUGHT IRON, STEAM-JACKETED FUSION KETTLE WITH PADDLE TYPE AGITATOR PROVIDED WITH SPIRAL FLOATS

ers, as shown in Fig. 4. This type of agitator is also used without breakers. Other modifications are the sloping shaft, as shown in Fig. 5, or off-center, as shown in Fig. 6. Either of these last two designs gives excellent agitation, the sloping type particularly so.

There is a variety of methods of construction for these agitators. There is one form of construction which consists in cutting the agitator from a piece of boiler plate and clamping it to the end of the shaft. This is sufficient for some purposes, but for most purposes it is not good construction. An improvement on this is to bolt the blades to a cast-iron hub, which is fastened to the shaft, and while this is sufficient for some purposes it is entirely unsuitable for others.

A further advance is to cast the agitator in two parts, bolting them together on a square shaft, as shown in Fig. 7. This method of construction has been extensively used.

The objection to all of these methods is that it is difficult, if not impossible, to keep the bolts tight. The contents of the kettle often have an action on the metal. This, coupled with the high temperatures used in the kettles, results in a severe condition of service.

The best way to build an agitator is to cast the agitator and shaft in one piece, with a hole through the length of the shaft through which a steel shaft is inserted when a bottom bearing is used. When a bottom bearing is not used the hole extends partly into the shaft, the stirring device being made fast with a key and clamp bolts, as shown in Fig. 6. When a bottom bearing is used, the construction shown in Fig. 1 is advisable, the bottom bearing being a removable plug, as shown. By following this construction the bottom bearing is easily repaired. No attempt is made that the plug shall be a nice fit in the kettle. However, it is made tapering.

Agitators for autoclaves must be very strongly built. In high-pressure autoclaves they are cast steel, keyed and pinned to a soft-steel shaft. The agitating shaft in an autoclave must be of ample size to take care of its load with an ample factor of safety, but at the same time it should be kept as small as possible, since with an autoclave working at a pressure of 1000 lb. per square inch, carrying a $2\frac{1}{2}$-in. shaft, there is an unbalanced

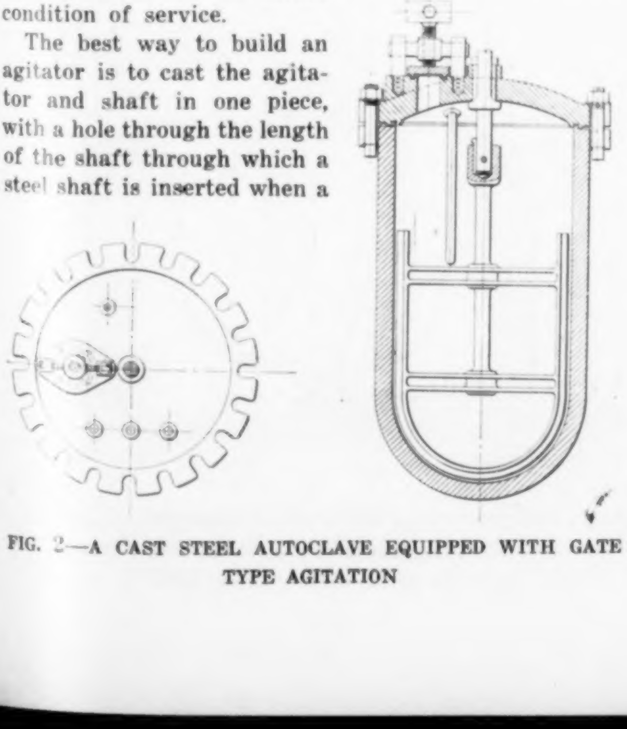


FIG. 2—A CAST STEEL AUTOCLAVE EQUIPPED WITH GATE TYPE AGITATION

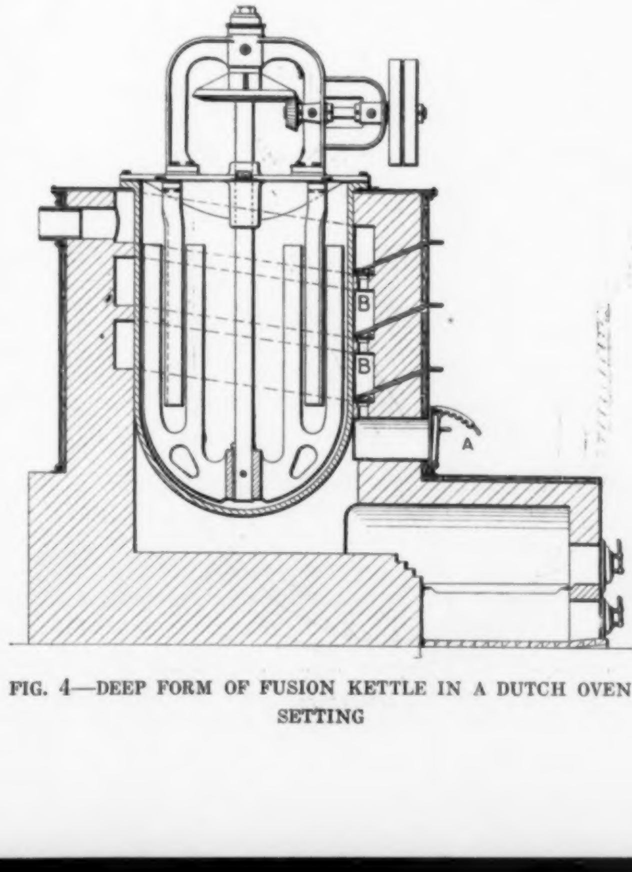


FIG. 4—DEEP FORM OF FUSION KETTLE IN A DUTCH OVEN SETTING

force of over 7800 lb. tending to drive the shaft out of the autoclave.

Conditions calling for the propeller type of agitator in an autoclave are rare, although in many instances an off-center agitator of the gate or horseshoe type is used to advantage. Autoclave agitators are often of the scraper type, as shown in Fig. 8, frequently supplied with floats inclined in one direction on one side, and in the opposite direction on the other, so that the contents of the autoclave are first lifted and then depressed.

In the wrought-iron, steam-jacketed type of fusion kettle the agitator can be either the ordinary paddle type, or paddle type with spiral floats, as shown in Fig. 3.

In the case of a vertical steel autoclave, working at comparatively low pressures, the agitator may be of any of the standard types—propeller, gate, or horseshoe—as the conditions of service indicate. In designing an autoclave of this type the propeller with the shaft inclined to the vertical should be carefully considered. The merits of this type of agitation are too seldom recognized.

A fusion kettle may be discharged from the top or the bottom. When it is discharged from the bottom by gravity there must be a bottom opening. A bottom-discharge kettle is impossible in such a setting as shown in Fig. 1. It is difficult to devise a satisfactory bottom-discharge kettle when it is fired with oil or coal, unless a Dutch oven or similar setting is used. The discharge pipe must be carefully protected with clay sleeves, or otherwise, to prevent local overheating, it being borne in mind that there is no circulation in the discharge pipe.

When bottom discharge is used, the best plan is to set the kettle without protection for the discharge pipe, but so arranging the heating that no flame, or only a soft flame, reaches the bottom of the kettle. An arrangement of this sort is shown in Figs. 4 and 6.

The system of burning producer gas, known as "flameless combustion," which is extensively used in England, is excellent for a fusion kettle with bottom discharge. In this case no protection of the discharge pipe is necessary.

Fig. 6 shows a system of combustion using gas coming into use in this country, which is also excellently adapted for fusion kettles with a bottom discharge.

In considering a bottom discharge it must be borne in mind that when caustic soda or caustic potash is used in fusions that if the discharge pipe is allowed to cool below the freezing point of these substances—which is 318 deg. in the case of sodium hydroxide, and 360 deg. in the case of potassium hydroxide—that it will be impossible to discharge the kettle without first

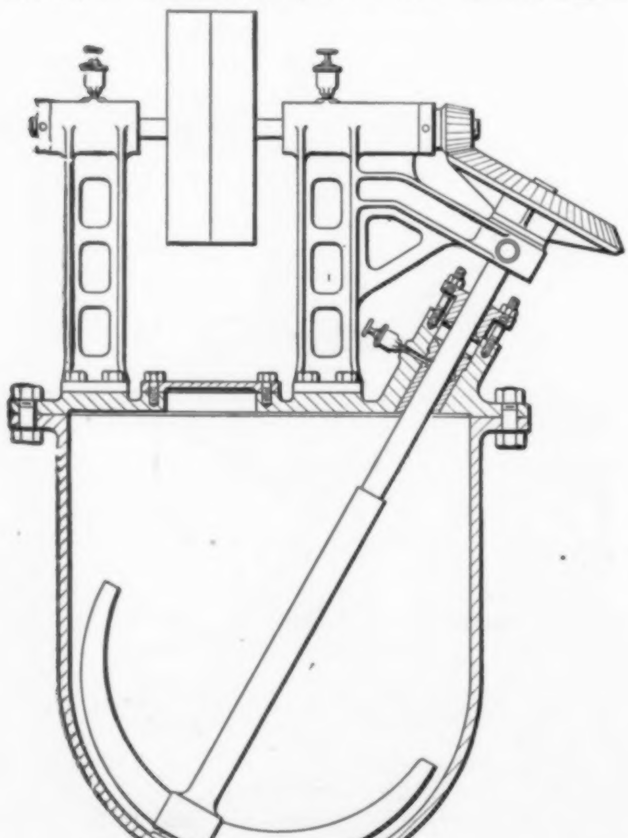


FIG. 5—FUSION KETTLE PROVIDED WITH SLOPING SHAFT AGITATOR

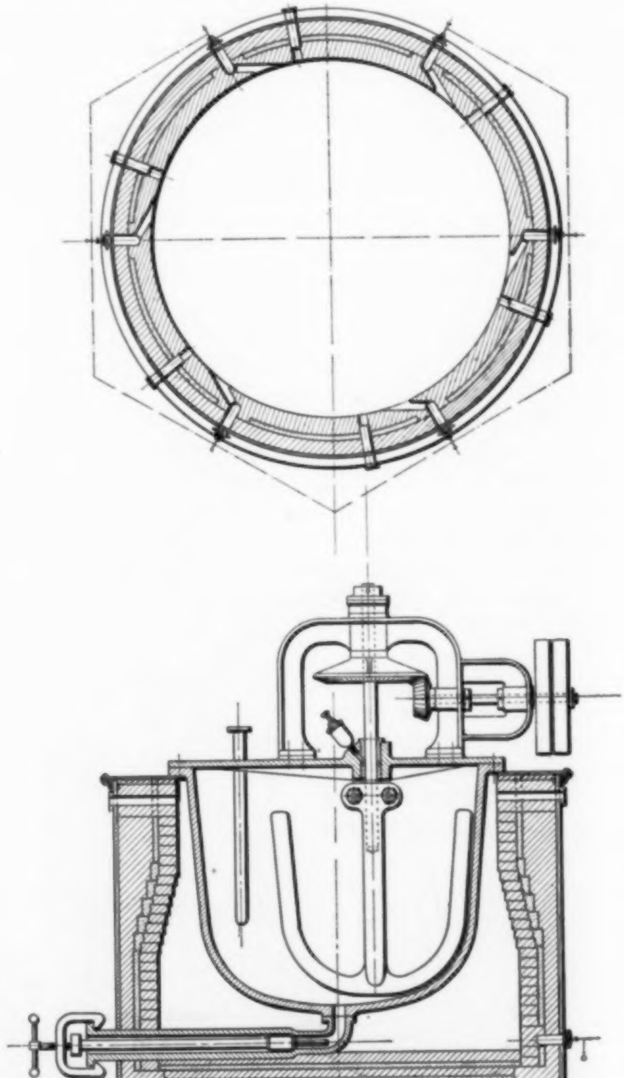


FIG. 6—FUSION KETTLE WITH OFF-CENTER TYPE AGITATOR IN A SETTING EXCELLENTLY ADAPTED FOR FUSION KETTLES WITH BOTTOM DISCHARGE

melting the contents of the discharge pipe. It is impracticable to use a valve or cock of the ordinary type to close the kettle. A successful way of overcoming this difficulty is to use a plug valve, such as shown in Fig. 6. Another method is to protect the pipe shortly after leaving the kettle, then surrounding it with a water jacket through which water is allowed to circulate, and using a plug valve as described (plug valve need not be especially tight). The water circulating through this jacket makes a seal of caustic. When ready to discharge the kettle the flow of water is stopped, the water in the jacket drained off, and the pipe heated up until the melting point of the caustic is reached, when the plug can be removed. This plan works very well, but is unnecessary if the plug valve is well made, is kept clean, and if the proper metals are used for the seat and valve. A number of alloys have been successfully employed for this service, some of the nickel alloys being especially good.

When the kettle is discharged from the top the contents must be either ladled out or the kettle tilted. Tilting is inadvisable for large kettles, except in instances that demand such a method of discharge. In other cases the design is such that the complete kettle and furnace tilt, the tilting mechanism being either a gear and worm or levers.

The contents of the kettle may be pumped out, either by using a centrifugal pump driven by a motor at the end of a long shaft, the centrifugal pump being lowered into the fusion kettle, or the kettle may be emptied by means of an injector with suction pipe extending to the bottom of the kettle.

In the case of an autoclave operating at high pressure, bottom discharge is not practicable. An autoclave is discharged either by first cooling and inserting a pipe to the bottom and "blowing" the charge by means of compressed air, gas or steam, or the cover of the autoclave may be taken off and the contents removed through the top.

In many instances it is possible to discharge an autoclave by means of a valve and discharge pipe attached to the cover of the autoclave, proceeding as follows: The contents of the apparatus is cooled to a determined temperature, the valve is then opened rapidly, most of the contents being discharged by belching action, the solids being carried out with the rush of gases. The balance of the contents may be removed by a pipe extending to the bottom and "blowing" with steam or compressed air, as before mentioned. In many cases, however, it is possible to discharge practically the entire contents of the autoclave by the quick opening of the valve on the cover.

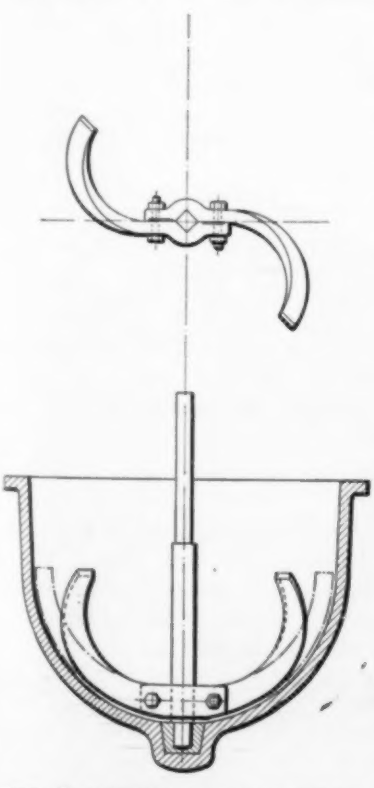


FIG. 7—METHOD OF CONSTRUCTING AGITATORS WHICH HAS BEEN EXTENSIVELY USED

Fig. 8 shows an autoclave in which a substance in powdered form is treated with a gas under pressure. In this case it is necessary that a large opening in the bottom be provided to conveniently discharge the autoclave.

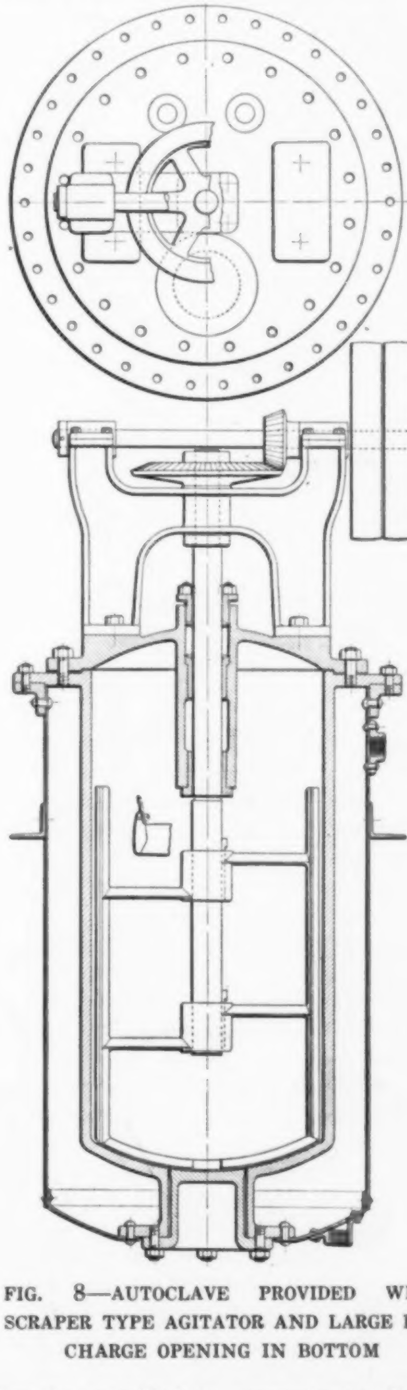


FIG. 8—AUTOCLAVE PROVIDED WITH SCRAPER TYPE AGITATOR AND LARGE DISCHARGE OPENING IN BOTTOM

Low-pressure autoclaves are discharged through an ordinary valve in the ordinary way.

A large variety of furnaces are used in connection with fusion kettles. Fig. 1 shows one adapted for burning crude oil. This is a very satisfactory furnace, is durable, and fairly economical.

Fig. 4 shows a type of furnace for burning coal.

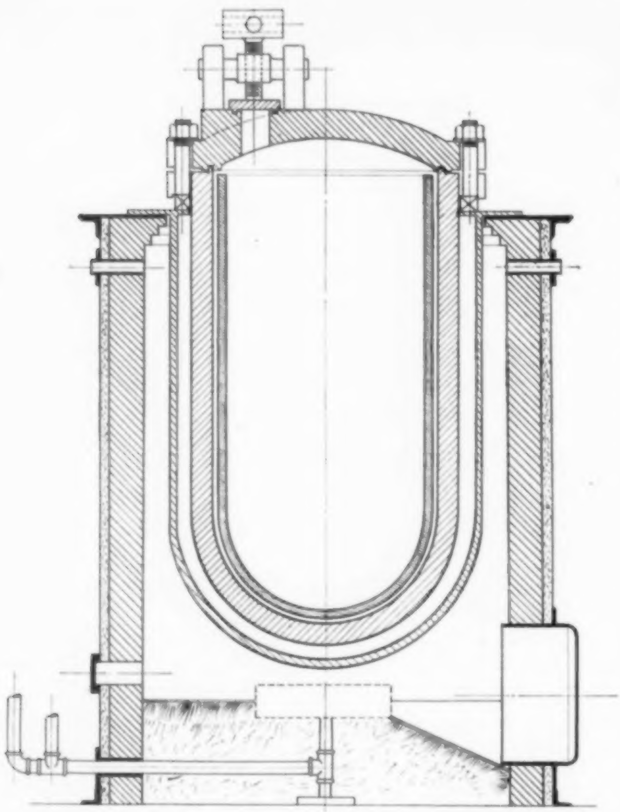


FIG. 9—AUTOCLAVE WITHOUT STIRRING DEVICE, PROVIDED WITH ENAMELED CHEMISE, IN A SETTING FOR BURNING GAS

This is a furnace used in a large phenol plant abroad. It is very satisfactory and most economical. The temperatures can be controlled with considerable accuracy by using the auxiliary door marked *A* for admitting cold air in connection with the dampers marked *B*. The setting is so built that the hot gases may circulate either around the kettle or pass through to the uptake by means of the dampers *B*. This gives a control independent of the fire. Of course, the temperature is also controlled by controlling the fire.

Fig. 6 shows a furnace for burning gas which is rapidly coming into use in this country. It is ideal for many purposes.

Fig. 9 shows another design for burning gas which is considerably used, but is not as economical as the first one.

In designing an autoclave, the question of lubrication must be given intelligent attention. For the main shaft, hard grease should be used instead of oil.

Fusion kettles should be provided with covers, not only to prevent loss of heat but to protect the workmen. They are usually arranged so that one-half of the cover may be easily opened on a hinge. When the cover of the kettle is so arranged no other opening is necessary for charging. Otherwise, there must be a manhole or some other opening in the cover for charging.

If the fusion is one giving off fumes or vapors, an outlet must be provided for a pipe to carry them off.

The kettle must be provided with a thermometer tube extending well into the mass. This is sometimes a wrought-iron tube with the end closed by welding. A better arrangement is to use a tube cast with a closed end; or, better still, one made from a solid bar, boring out the hole with a gun bit. If the thermometer tube is long, care must be taken that it is well supported to resist the strains occasioned by the moving mass in the kettle. The bulb of the thermometer tube should be packed with a mixture of precipitated copper and graphite, or other substances, such as heavy oil or mercury; *e.g.*, depending upon the temperature and the material of which the thermometer bulb is made.

A recording thermometer is more satisfactory than a simple indicating thermometer. Electric pyrometers are used, and well thought of by some operators. When an electric instrument is used for a battery of kettles there is usually one indicating instrument for all the kettles, arranged through switch connections, so that the temperature in any kettle may be read. The importance of control in a chemical factory is becoming more and more recognized. A recording thermometer is a distinct aid to chemical control.

There are a number of special cast irons on the market that for many purposes are more advantageous than ordinary cast iron. One of these special metals, well chosen for the purpose it is to serve, will give a much longer life to a kettle than ordinary cast iron.

Autoclaves are equipped with safety valves and manometers. Great care must be used in connection with both parts of these pieces of apparatus, in that they are so designed and so arranged that they will not become plugged up from the contents of the autoclave. When a safety valve is used it must be so arranged that it will discharge into a protected place, so that the discharge cannot injure the workmen.

Autoclaves for high pressure are made usually from cast steel or forged steel. When an autoclave is made from cast steel it must be cast bottom down, with a heavy sink head to be machined off. Large autoclaves for very high pressures have been successfully made abroad from forged steel, and are for most purposes superior to cast autoclaves.

It is not the intention that this article shall be a treatise on the detail and design of autoclaves, but the following formula is useful in checking the thickness of the walls of an autoclave:

LAMÉ'S FORMULA

$$t = \frac{d}{2}\left[\left(\frac{h+p}{h-p}\right)^{1/2} - 1\right]$$

t = thickness of autoclave wall.
p = working pressure in autoclave.
d = inside diameter of autoclave.
h = maximum allowable hoop tension at interior of cylinder.

(For further information see Merriman's "Mechanics of Materials.")

It is often necessary that acid fusions be made, in which case a lining must be provided. Lead, silver and nickel have all been successfully used as autoclave linings. In some cases a chemise of enameled metal is used, in which case the space between the chemise and autoclave is filled with lead or similar metal, poured in while molten.

The joint between the cover and autoclave is sometimes troublesome. For this purpose lead is often poured into the groove in the autoclave, a tongue in the cover making the joint against the lead. Copper or silver wire is successfully used in the groove. A flat,

corrugated steel gasket is another successful type. A special gasket known under the trade name of "Flexitallic" has been found successful for many uses.

Fig. 9 shows an autoclave without a stirring device equipped with an enamel chemise. This is an example of the sort of autoclave used for such products as dimethylaniline.

The Effect of Addition Agents in Flotation

By M. H. Thornberry and H. T. Mann

In the great amount of literature published on the subject of flotation, including many articles by able technical men, descriptions of patents covering various flotation processes and data on many of the flotation installations throughout the country, are to be found numerous statements indicating that certain factors, such as slight acidity and alkalinity and the presence of small quantities of soluble salts, have shown marked influence upon the separation of the mineral from the gangue, or in the separation of one mineral from another. Our own experience has confirmed this frequent appearance of a preponderant influence of some wholly unexpected factor, and it is the object of the following investigations to obtain more exact data concerning one class of such factors, namely, the influence of the commoner inorganic salts.

The work as outlined covered tests on three ores: a lead ore from southeast Missouri, a zinc ore from southwest Missouri, and a mixed lead and zinc ore from southwest Missouri. Only a part of the work on the lead ore is reported at this time. However, the portion of the work on the zinc ore already completed is similar in its results, and these data will be published later.

Tests on Lead Slime

The lead ore used in the following experiments is a typical slime from the southeast Missouri lead district. The chemical analysis of one sample is as follows:

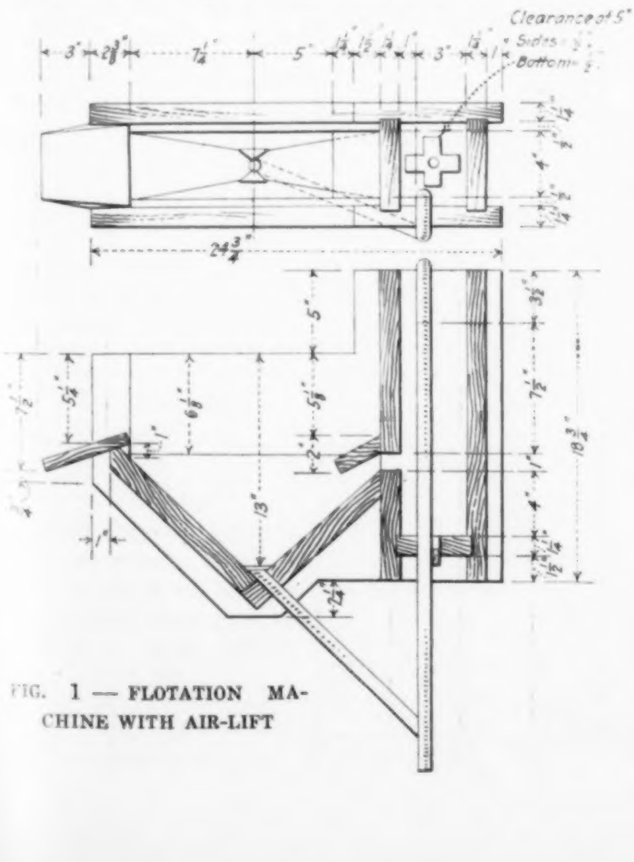


FIG. 1 — FLOTATION MACHINE WITH AIR-LIFT

	Per Cent		Per Cent
Pb	4.64	Cu	0.00
Zn	0.30	CaO	22.68
Fe	3.51	MgO	13.11
S	3.57	Insoluble	16.68

The screen analysis of this material shows the following results:

	Mesh	Average Size of Opening, Mm.	Percentage	Per Cent, Lead
On	28	0.589	0.00	0.00
On	35	0.417	1.00	1.21
On	48	0.295	0.60	2.82
On	65	0.208	1.60	3.20
On	100	0.147	4.60	3.07
On	150	0.104	15.20	3.41
On	200	0.074	36.80	4.87
Through	200	....	40.20	6.14

Tyler standard screens were used and the material was shaken for 40 minutes on the Ro-Tap.

This slime was barreled wet and when received it contained from 10 per cent to 15 per cent moisture. The material was not dried, and as our water supply has practically the same analysis as the water with the ore, tap water was used in the tests, since it was thought no advantage could be gained by the use of distilled water. The feed did not contain a constant percentage of lead in all experiments, but the variation was small, ranging from 4.30 per cent to 4.64 per cent lead. This is due to the fact that more than one barrel of pulp was used in these tests.

All solutions and emulsions contained 5 per cent of the salt by weight in water. The quantities used were 5 cc., 15 cc., 25 cc. and 50 cc. per charge of approximately 800 grams of dry ore. These quantities are equivalent to 0.625, 1.875, 3.125 and 6.25 lb. respectively of the salt per ton of dry ore.

Flotation Machine with Air-Lift

The machine used for this work was designed in the flotation laboratory and built in the school shops, and is a modified form of the Minerals Separation type machine as illustrated and described in the *Engineering and Mining Journal* of September 4, 1915.

It was found that the original machine did not have sufficient suction to keep either a charge of coarse ore or a charge of ore with a high sulphide content in circulation, hence the air-lift was substituted to overcome this difficulty. This particular type of machine, with all modifications, produces a concentrate having a higher metallic content than that produced in the original machine, due to the fact that it gives a greater area for froth and at the same time allows the froth to accumulate at a point where the currents due to the inflow of pulp from the agitation compartment have little effect. A drawing of the apparatus is shown in Fig. 1.

The various modifications of the original machine may be found in the Missouri School of Mines *Bulletin*, Vol. 3, No. 1.

Conditions of Experiments

Tests were first run on this ore with a large variety of oils from which three were selected for this work. The results on each oil have been plotted and may be found in accompanying charts. Chart I shows the results obtained with Cleveland Cliffs Iron Company's flotation oil No. 1 (hardwood creosote). Chart II shows the results obtained with General Naval Stores

flotation oil No. 17, and Chart III shows the results obtained with cresylic acid.

The method of conducting the experiments is as follows: The moisture was determined and a charge of wet pulp containing approximately 800 gm. of dry ore was weighed and poured into the machine with sufficient tap water to give the charge a dilution of five of water to one of dry ore by weight. The machine was started and the desired quantity of the reagent added. After a thorough mixing oil was added at the rate of 0.5 lb. per ton and the froth skimmed off as fast as it raised above the overflow of the machine. A bubble column of about 2 in. was carried until the very last of the experiment when all froth was skimmed off. This practice undoubtedly, to some extent, raises the extraction and lowers the grade of concentrate, but as this procedure was uniform throughout the results are comparable. The duration of the test was 40 to 45 minutes, and the speed of the machine 1700 r.p.m.

All operating conditions, such as the speed of the impellor, duration of the test, volume of pulp in machine, etc., were kept as uniform as possible. In so large a number of experiments slight variations were unavoidable. These would necessarily cause slight variations in the results obtained; but nearly every result in the charts has been checked once, and where there was a pronounced variation in either extraction or grade of concentrate, the results have been checked several times.

Discussion of Results

In the discussion of the results shown in the charts, the effect of each sulphate with the three oils will be considered separately, after which they will be thrown into groups and considered in a general manner.

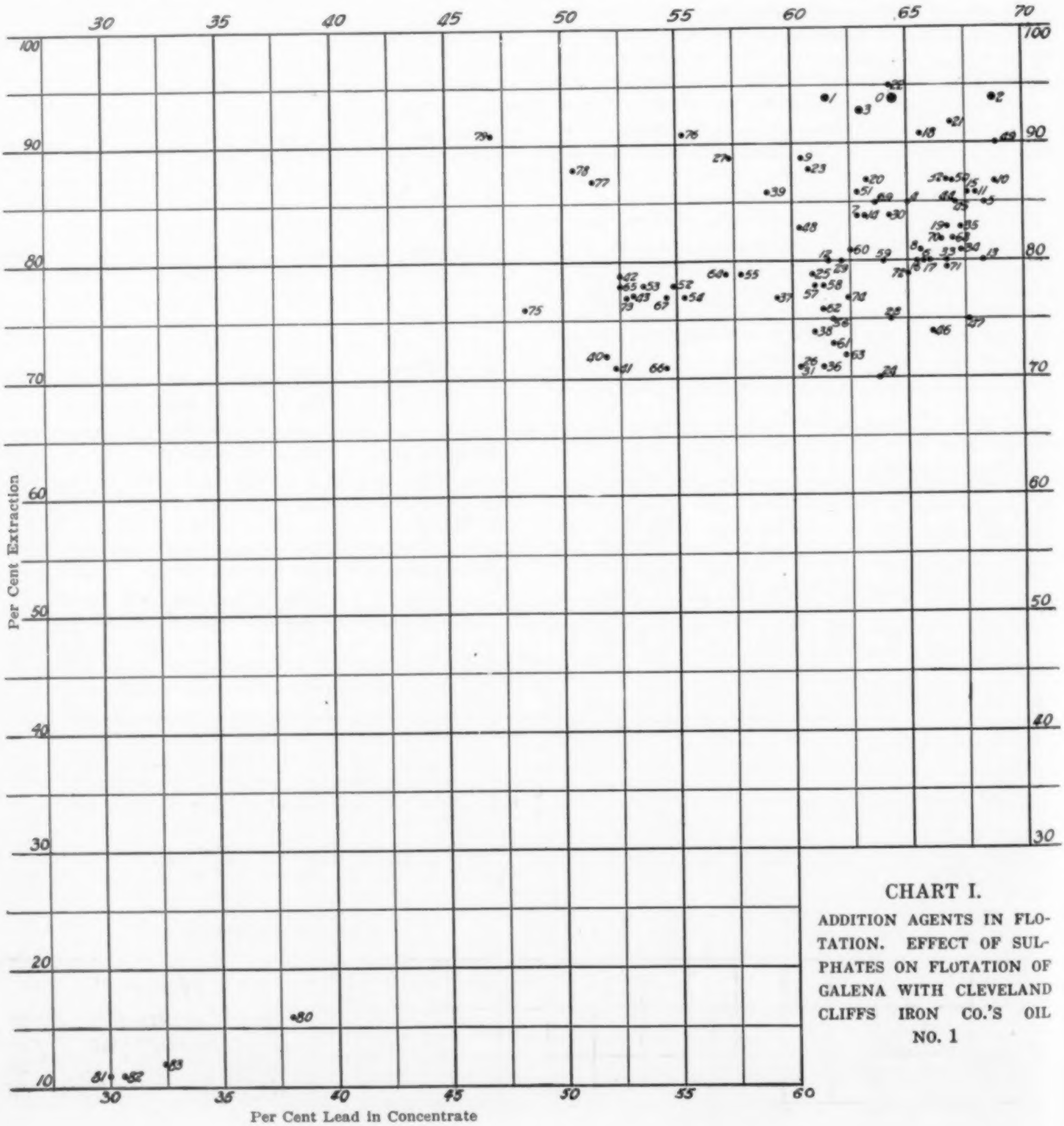


CHART I.

ADDITION AGENTS IN FLOTATION. EFFECT OF SULPHATES ON FLOTATION OF GALENA WITH CLEVELAND CLIFFS IRON CO.'S OIL NO. 1

SULPHURIC ACID AND ALKALI-EARTH SULPHATES

The numerals shown on the charts are the numbers of the various experiments, three being made without any addition agent and four each with the different addition agents. Those without addition agents are numbered 1, 2, 3 and 0, the last showing the average results of the first three. The numbers of experiments with addition agents are given in the following paragraphs, four to each experiment, and indicate results obtained respectively with 5, 15, 25 and 50 cc. of each agent.

H_2SO_4. Nos. 4 to 7. When sulphuric acid is added the extraction is lowered without any apparent change in the grade of concentrate produced. This indicates that southeast Missouri lead ores will give better results without acid than with it.

$MgSO_4$. Nos. 8 to 11. The addition of magnesium sulphate lowers the extraction without any great change in the grade of the concentrate produced.

$CaSO_4.2H_2O$. Nos. 28 to 31. Calcium sulphate gives rather erratic results. With oils which produce a clean concentrate with a good extraction, the presence of this reagent lowers the extraction without any great change in the grade of concentrate produced; but with an oil which tends to lift the gangue, its presence seems to improve the extraction.

$BaSO_4$. Nos. 32 to 35. Barium sulphate has practically the same effect as calcium sulphate.

General. The action of sulphuric acid, which with this ore forms calcium and magnesium sulphates, and the action of the individual sulphates of the alkali earths are very similar. With the exception of barium and calcium sulphates when used with cresylic acid, the extraction is lowered about 10 per cent and there is very little difference in the grade of concentrate produced.

ALKALI SULPHATES

$Na_2SO_4.10H_2O$. Nos. 24 to 27. The presence of sodium sulphate seems to have little effect on the grade of concentrate produced, but it does have a noticeable effect on the extraction obtained. The extraction may be better or poorer, depending upon the quantity of sodium sulphate used and on the oil used.

K_2SO_4. Nos. 16 to 19. When potassium sulphate is added, both the extraction and the grade of concentrate are lowered to some extent.

$(NH_4)_2SO_4$. Nos. 52 to 55. The results obtained when using ammonium sulphate shows that the results depend more on the oil used than on the quantity of the salt present in solution. The results do not deviate sufficiently to make experimental work promising.

$KHSO_4$. Nos. 44 to 47. The tendency of potassium acid sulphate is to give a concentrate of slightly higher grade while it decreases the extraction.

$NaHSO_4.H_2O$. Nos. 48 to 51. The results obtained when using sodium acid sulphate are somewhat erratic.

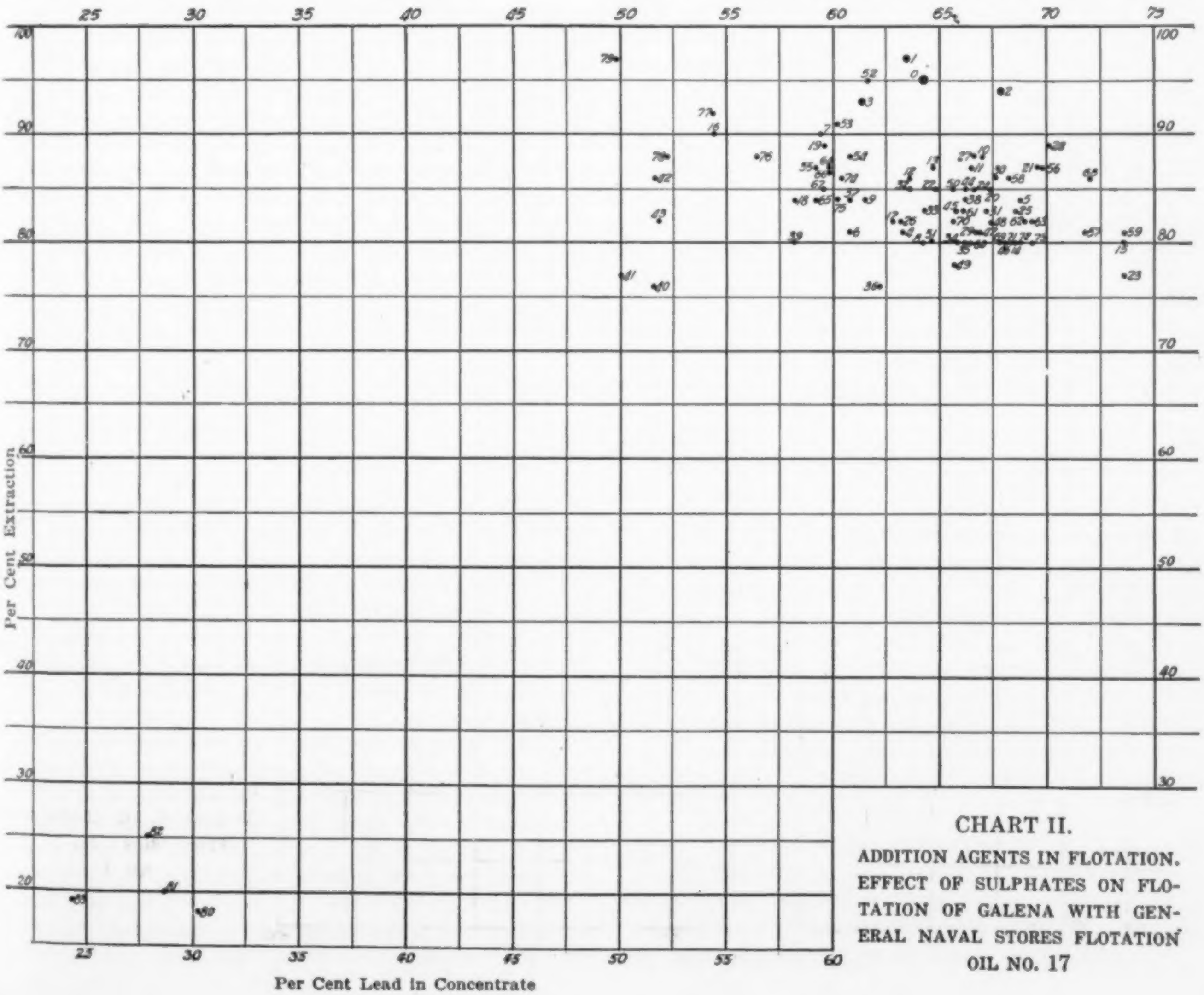


CHART II.

ADDITION AGENTS IN FLOTATION. EFFECT OF SULPHATES ON FLOTATION OF GALENA WITH GENERAL NAVAL STORES FLOTATION OIL NO. 17

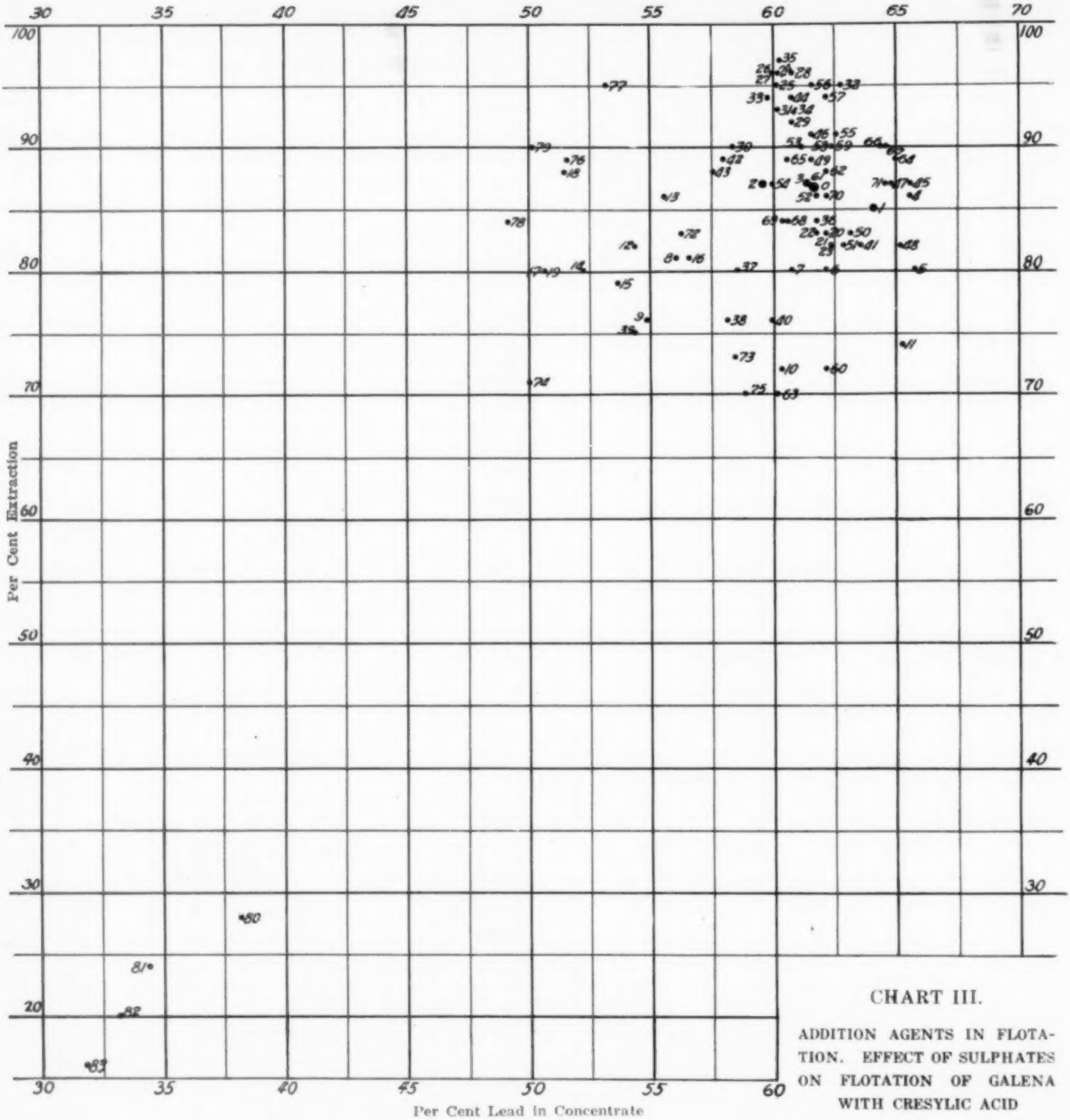


CHART III.

ADDITION AGENTS IN FLOTATION. EFFECT OF SULPHATES ON FLOTATION OF GALENA WITH CRESYLIC ACID

As there are no great variations either in the grade of concentrate or in the extraction, no attempt was made to determine if there were critical quantities which would produce a marked result.

General. The acid and normal sulphates of the alkalies do not show sufficient deviation from each other, either from the results obtained when using oil alone, or from the results of one when compared with the results of another, to make further experimental work desirable at this time.

ALUMS

$Fe(NH_4)_2(SO_4)_2.6H_2O$. Nos. 56 to 59. The concentrate obtained when ferrous ammonium sulphate was added was of a little better grade than that produced with oil alone. The extraction varied with the oil used.

$KAl(SO_4)_2.12H_2O$. Nos. 60 to 63. When potassium alum was used it showed a tendency to improve slightly the grade of concentrate. It lowers the extraction to such an extent, however, that the improvement in the grade of concentrate is of no interest.

$NH_4Al(SO_4)_2.12H_2O$. Nos. 64 to 67. The effect of ammonium alum, when the results are considered as a whole, is to lower both the grade of the concentrate and the extraction.

$NH_4Fe(SO_4)_2.12H_2O$. Nos. 68 to 71. When ammonio-ferric alum was added, the extractions were lowered considerably with the oils which give a high extraction when used alone. With cresylic acid there is practically no change in the extraction. The grade of concentrate is improved, slightly varying with the oil used.

$KCr(SO_4)_2.12H_2O$. Nos. 72 to 75. When the percentage of lead in the concentrate is considered, chrome alum does not have much effect. The results are rather

erratic, but the extraction is uniformly lowered by the use of this salt.

General. When considering the alums and ferrous ammonium sulphate as a whole, the action of all these salts is very similar to those that have been discussed, and for that reason no further discussion will be attempted.

METALLIC SULPHATES

$MnSO_4.4H_2O$. Nos. 20 to 23. Manganese sulphate when present in solution has little effect on the grade of concentrate produced. It does lower the extraction slightly.

$FeSO_4$. Nos. 12 to 15. The presence of ferrous sulphate causes variable results. With the oils which give a clean concentrate and high extraction, it lowers the extraction but has little effect on the grade of concentrate produced. With cresylic acid the lead tenor of the concentrate produced is noticeably lower.

$HgSO_4$. Nos. 36 to 39. The effect of mercuric sulphate is to lower the extraction without any very great change in the lead content of the concentrate.

$CuSO_4.5H_2O$. Nos. 40 to 43. Copper sulphate lowered the extraction very noticeably and also lowered the lead content of the concentrate. This is just the opposite of the results found in many cases when floating zinc ores.

$ZnSO_4.7H_2O$. Nos. 76 to 79. Zinc sulphate gives variable results. When considering the extractions it will be noted that some of them are a little higher and some slightly lower than when oil alone is used. Taken as a whole, the effect on the extraction is negligible, though it does cause a noticeable lowering of the lead content of the concentrate. When zinc sulphate is present one might be justified in giving the pulp a preliminary water-wash in order to raise the grade of the concentrate and thereby save freight and smelting charges.

$CdSO_4.8H_2O$. Nos. 80 to 83. The presence of cadmium sulphate is very detrimental, practically ruining both the extraction and the grade of concentrate obtained.

Conclusions

Generally speaking, when the sulphates are present the tendency is to lower both the grade of concentrate produced and the extraction. There are, however, a few exceptions to this rule. For instance, when using sodium sulphate with cresylic acid about the same grade of concentrate is produced, but the extraction is noticeably higher. While a few instances may occur in which a certain salt has a slight beneficial effect, this effect is not nearly so pronounced as the detrimental effect of cadmium sulphate. In fact, the position of cadmium is quite unique among the other salts and for this reason it is our intention to publish later a study of the behavior of cadmium salts generally, hence no further discussion of this striking singularity will be attempted here.

The poor extraction obtained when sulphates are present can be overcome in some cases by giving the pulp a longer treatment. This, however, lowers the capacity of a given machine and increases the cost of treatment.

Experiment Station and Dept. of Metallurgy,
School of Mines and Metallurgy,
Rolla, Mo.

The Electrolytic Pickling of Steel

M. De Kay Thompson and F. W. Dodson

In a recent article[1] it has been shown that for the kind of mill-scale tested, electrolytic pickling results in a saving in expense over the ordinary chemical method. In these tests all of the scale removed by the chemical treatment was dissolved after the pickling was over, and counted in with the iron dissolved in the pickling operation itself. This gives the most favorable comparison for the electrolytic method. The least favorable comparison for the electrolytic method would be to filter off all the scale right after chemical pickling and analyze for the iron in solution. In the previous experiments the mill-scale used in the tests was made by heating a piece of steel in a muffle, and therefore did not correspond exactly to what must be treated in practice.

The following experiments were made on black sheet-iron kindly furnished by the American Sheet and Tin Plate Company, and on some transformer sheet-iron containing silicon from the General Electric Company. The sheet was cut into sizes that could be placed in a narrow rectangular glass electrolysis vessel 15 cm. long by 15 cm. deep by 5 cm. wide. A number of the sheets were pickled, and the solution was then analyzed for iron. The amount of iron also gives the quantity of acid used. Lead anodes were used and sulphuric acid of specific gravity 1.19. The surface of the black iron after pickling was a silvery white and very clean, quite different from the pickled surface in the previous experiments. The surface of the chemically pickled sheets was not so clean, but was covered by fine black particles which did not wash off easily but which could be removed by rubbing to loosen them and then washing.

In the chemical pickling the sheet-iron was dipped into hot acid 4.5 per cent by weight, and was removed when the pickling was considered complete. The scale which collected at the bottom of the vessel containing the acid was filtered off and the dissolved iron determined by analysis.

The following data are for the sheet-iron from the American Sheet and Tin Plate Company:

Experiment No	1	2	3	4	5
Amperes	9.1	8.0	8.0	8.0	8.0
Amp. per cm2	0.058	0.044	0.033	0.047	0.055
Volts	2.70	2.50	2.68	2.90	2.66
Duration of pickling, min	3.0	2.0	5.25	3.0	3.0
Temperature, deg. C	59.5	59.5	65.	60.	60.
Sq. cm. pickled	156.	182.	246.	170.	146.

The total area of iron pickled was 900 square centimeters and its weight was 241 grams. The amount of iron dissolved was 2.88 grams, or 0.0032 gram of iron per square centimeter of surface.

Ordinary chemical pickling of the same iron gave the following results:

Experiment No	1	2	3	4	5
Time	3	8	4	3	6
Square centimeters	111	138	168	183	169
Temperature, deg. C	100	95	99	99	98

Total area 769 square centimeters, and 2.97 grams of iron were dissolved, or 0.00386 gram per square centimeter. Referring to the weight of the sheets, 1.20 per cent is dissolved by the electrolytic pickling, 1.44 per

[1]Thompson and Mahlman, Tr. Am. Electroch. Soc., May, 1917.

cent by chemical, or a saving of 0.24 per cent by weight of the sheet pickled. In 2000 pounds of black sheet-iron there would be a saving of 4.8 pounds of iron and a corresponding amount of acid. This is a small saving if this were all. The other advantages to be considered are that the surface of the electrolytically pickled iron is much better and that the acid is used at a lower temperature and therefore not so dangerous to the workmen. Also the scale does not fall off to be discarded, but is reduced and practically no iron is lost except that which goes into solution as sulphate.

Samples of silicon transformer sheet-iron from the General Electric Company were next tried. Two kinds of iron were received, one with a blue scale which cracked off when the iron was bent, exposing the white metal beneath. The scale of the other sample had the usual appearance of black sheet-iron. Right under the outside scale in both samples there was a thin layer of rust.

The cell used for pickling the silicon iron was a porcelain cup lined with wax to protect from hydrofluoric acid. Lead anodes were used as in the previous experiments. The pickling liquor was a mixture of 35 per cent by weight of sulphuric and 2 per cent hydrofluoric acids. When pickled electrolytically in this solution the surface came out a silvery white, but it was not possible to do chemical pickling with this solution.

The results with the sample covered with blue, brittle scale were as follows:

Experiment No.	1	2
Amperes	2.5	2.5
Amp. per sq. cm	0.082	0.088
Volts	3.65	2.90
Duration, minutes	19.	45.
Temperature	20.	20.
Area, sq. cm	30.6	28.4

Only 0.3 per cent of the weight of the plate was dissolved but an exceptionally long time was required to remove the last particle of scale. Most of it was removed in three minutes.

The following results were obtained with the sample that had more the appearance of ordinary black sheet:

Experiment No.	1	2	3	4
Amperes	3.	3.	3.	3.
Amperes per sq. cm	.067	.071	.070	.073
Volts	3.2	3.1	3.3	3.2
Duration, minutes	5.	4.	3.	2.
Temperature, deg. C	24.	24.	24.	24.

The amount of iron dissolved was 1.3 per cent of the weight of these sheets, or .0016 gram per square centimeter.

The chemical pickling, using the same acid, gave the following results:

Experiment No.	1	2	3	4
Duration, minutes	9	13	9	13
Area, sq. cm	42	40	38	39
Temperature, deg. C	24	24	24	24

The weight of iron dissolved per square centimeter of surface is 0.002 gram, not very much in excess of that dissolved by the electrolytic pickling.

Summing up the results of the comparative tests of electrolytic and chemical pickling on the kinds of scale tested, these tests do not show any very striking advantage of the electrolytic over the chemical pickling, as far as the amount of acid used is concerned. There are, however, in favor of the electrolytic method, the advantages of using a lower temperature and of getting a better surface. It is very probable that the amount of iron dissolved by the two methods varies considerably with different kinds of scale.

A single test was made on boiler plate which was reported to require two and one-half hours chemical pickling. Eight minutes of electrolytic pickling was found sufficient. It appears therefore that the thicker the scale the greater the relative advantage of the electrolytic method.

The question has been raised as to whether the ferrous sulphate has any appreciable effect on depolarizing the anode. In order to see what this might amount to a diaphragm cell was arranged with sulphuric acid in the cathode, and sulphuric acid in the anode, which could be changed to sulphuric acid and ferrous sulphate without changing anything else about the cell.

It will be seen from the table below that with a large amount of ferrous sulphate the voltage was practically the same as without it. Therefore the small amount of ferrous sulphate in a pickling cell could have no appreciable depolarizing effect.

Other tests were made with practically the same result.

Depolarizing Action of Ferrous Sulphate

	30 per Cent Acid Solution in Anode		30 per Cent Acid and 10 per Cent Ferrous Sulphate Solution in Anode	
Volts	2.85	2.83	2.85	2.90
Amperes	7.2	7.2	7.2	7.2
Temperature, deg. C.	60	60	64	64

Massachusetts Institute of Technology.
Cambridge, Mass.
September, 1917.

Additions to Prohibited Import List

The following articles will require a license by the War Trade Board to be imported, in accordance with a proclamation issued on Nov. 30, by the President: Antimony, antimony ore, or any chemical extracted therefrom; asbestos; beans of all kinds; balata; burlap; castor seed, castor oil; cotton; chrome, chrome ore, or any ferro-alloy or chemical extracted therefrom; cocoanut oil; cobalt, cobalt ore, or any ferro-alloy or chemical extracted therefrom; copra; industrial diamonds; all ferro-alloys; flax; gutta joolatong; gutta percha; gutta siak; hemp; hides and skins; jute; iridium; leather; manganese, manganese ore, or any ferro-alloy or chemical extracted therefrom; mica, molybdenum, molybdenum ore, or any ferro-alloy or chemical extracted therefrom; naxos emery and naxos emery ore; nickel, nickel ore, matte, or any ferro-alloy or chemical extracted therefrom; sodium, potassium; or calcium nitrates; optical glass; palm oil; platinum; plumbago; pyrites; rice, rubber, raw, reclaimed, waste or scrap scheelite; shellac; sisal; soya bean oil; spiegeleisen; sugars; tanning materials; tin in bars, blocks, pigs, or grain or granulated; tin ore and tin concentrates, or any chemical extracted therefrom; titanium, titanium ore, or any ferro-alloy or chemical extracted therefrom; tobacco; tungsten, tungsten ore, or any ferro-alloy or chemical extracted therefrom; vanadium, vanadium ore, or any ferro-alloy or chemical extracted therefrom; wheat and wheat flour; wolframite; or wool.

Efforts of the French Chemical Industries During the War

Among the important changes which have taken place in all the trades and industries of France because of the extraordinary demands of the great war and the unexpected difficulties in obtaining many of the generally used raw products, there are several which have special interest for the American chemical industry.

One of the very latest steps taken in France, says the *Bulletin de la Société d'Encouragement pour L'Industrie Nationale* for July-August, 1917, is that of the manufacture of ashless filters, something which had not before been attempted, and which even now is but in its rudimentary stages. M. Durieux has perfected a type of closed cartridge of cellulose pulp for the filtration of materials dissolved in volatile solvents.

Following the great battle of the Marne, rush orders were given to all powder factories to manufacture at once enormous quantities of powders and other explosives, the consumption of which had surpassed by far all previous calculations. To describe exactly what was done must be left to the future, when the history of the war comes to be written; for the present only a few examples can be given. Phenol and crésol came to France from foreign countries, and not even the distillates of the coal mined and burned in France were used in anything like the extent to which coal tar had entered into the industrial chemistry of Germany. The war department demanded large quantities of trinitrophenol, or picric acid, and trinitrotoluol. The situation had to be worked out in three different directions, therefore.

First, the Gas Light, Heat and Power Company, in its main plant at Gennevilliers, undertook to treat all its tar products, especially those rich in naphthaline, and to recover the phenols and toluols, and some of their higher homologs. These tars were treated with an alkaline solution, and furnished, after acidification, a mixture of phenol products consisting of 12 per cent water, 25 per cent phenol, 12 per cent orthotoluol, 35 per cent meta- and para-toluol, 16 per cent of xylol, etc. Phenol and the toluols are separated from the solution by fractional distillation and crystallization. The company has succeeded recently in producing ortho-toluol, meta-toluol and para-toluol. However, in practical work these two are not separated, as their boiling points are but six-tenths of 1 deg. Cent. apart. When manufacturing explosives, meta- and para-toluol are treated with nitric acid, which transforms the para into oxalic and carbonic acids, while the meta is transformed into trinitrotoluol.

The production of phenol from the coal tar derived in the French gas companies is far too small to be sufficient for the enormous demands of modern warfare (1 ton of coal gives about 1 kg. of crude phenol, which equals about 200 gram of pure phenol). It has been necessary, therefore, to have recourse to the synthetic production of phenol from a benzine base. Synthetic phenol and the intermediary product, benzene sulfonate of sodium, are made at several plants.

The difficulties were finally solved when the Liquid Air Co. and the Chemical Factories of the Rhone undertook the manufacture of dinitrotoluol, starting from chlorobenzine and winding up in dinitrochlorobenzine. Besides dinitrotoluol, several other intermediary products have been made, such as orthonitrochlorobenzine, paranitrochlorobenzine and dichlorodinitrobenzine. Stability of the powders manufactured by these processes was obtained by the use of diphenylamine (in the Rhone factory) and dimethyldiphenylurea.

Chlorine gas was never produced in its pure state, but solely in chemical combination with calcium and hydrogen as CaCl and HCl; now it is made by a number of companies, in the electrolytic and liquid form. Among the new and important explosives manufactured with chlorine as main constituent are chlorobenzene and its derivatives, carbonoxichloride, tetrachloride of tin, and the perchlorates of sodium, potassium and ammonium.

Among the chemical products used in metallurgy which now must be produced in France because of the difficulties of importation should be mentioned ferrocerium, of which one company alone turns out 300 kg. per month. Magnesium is also manufactured in the Clavaux Works, where magnesium chloride is subjected to electrolysis. The largest portion of all the magnesium made here is turned over to another company, which makes a specialty of *duralumin*, an alloy of aluminium, magnesium and copper. This alloy has the density of 2.8, or very nearly that of pure aluminium, yet its strength is nearer that of soft steel.

Three chemical "novelties," so to say, were shown at the chemical exposition held in June last in Paris. They were synthetic acetic acid, synthetic acetic anhydride and synthetic alcohol. All three are directly obtained from acetylene by transformation into acetic aldehyde in the presence of a mercury salt. An oxidizing agent transforms the aldehyde into acid. If acetic acid, under certain conditions, is permitted to act upon acetylene in the presence of a mercury salt, acetic anhydride is formed, which is greatly in demand for the manufacture of acetate of cellulose. If ethylate of aluminium, or a similarly powerful catalyzing agent, is permitted to act upon acetic anhydride in the presence of chloride of aluminum, the anhydride is changed into ethyl acetate, which can easily be transformed into alcohol by saponification.

Not only the manufacture of chemicals, but also the construction of chemical glassware and porcelain apparatus for the laboratories, has furnished French scientists with problems of the most vital and important kind. Shortly after the beginning of 1915, chemical laboratories throughout France felt the lack of Jena and Bohemian glassware, and there seemed no immediate relief in sight. Soon, however, some of the largest glass factories undertook to produce the special kinds of chemical glass needed, according to analyses made of several kinds of Jena and Bohemian glass. Tests which have been made by the laboratory of Arts and Industries show that these glasses are equal in performance to the famous German products, and meet all the requirements demanded by the laboratory at Charlottenburg, Prussia, the clearing house for chemical glassware in Germany. Among the special glass products turned out, and exhibited at Paris, are "tuboserum," which is intended to take the place of the neutral Jena glass, and a drop-counting pipette. Insulated bottles, intended especially for aviators, are now manufactured by M. Berlemont. They were imported heretofore from Germany and Switzerland.

Recent Metallurgical and Chemical Patents

Colored Smoke

Smoke-Producing Compound.—WALTER ARTHUR of Philadelphia, Pa., patents a composition for the production of colored smoke for use in military operations. In military operations it is frequently advisable to indicate, either by the use of lights at night, or smoke in the day time, the position of troops, and the course taken by shells, by the combustion of materials capable of producing distinctive colors. Smoke which is white or black or grayish cannot ordinarily be employed, since such smoke is likely to be confused with the smoke produced by various explosives employed. In the present patent it is proposed to use cadmium metal, finely divided, or an oxidizable compound, such as the sulphide. These produce a brownish smoke, which from a distance has a bright orange appearance. The cadmium metal or cadmium compounds employed are preferably mixed with oxidizing agents, such as nitrates, chlorates, perchlorates, specific examples being barium nitrate, potassium chlorate, ammonium nitrate, potassium perchlorate, sodium nitrate, or mixtures such as potassium nitrate and barium nitrate. The mixture containing the cadmium material and the oxidizing agent can be burned in a variety of ways, as fusee torches, or in some cases merely packages of the powdered material. (1,244,940, Oct. 30, 1917.)

Miscellaneous Chemical Products

Toluene.—A process for the production of toluene and propane from spruce turpentine is patented by RALPH H. MCKEE of Orono, Me., and assigned to the New Process Gasoline Co. of Philadelphia, Pa. Spruce turpentine is a waste product resulting from the manufacture of cellulose or fibers from spruce and similar woods, such as balsam and fir, by boiling it under pressure in suitable digesters with a solution containing sulphurous acid and a base or bases, such as lime or lime and magnesia, according to what is known as the "sulphite process."

In the practice of the process the spruce turpentine is first separated from the sulphur dioxide gas and tarry products with which it is associated. This purification is effected by distilling the crude turpentine in the presence of steam, the distillation being continued until from approximately 80 per cent to 90 per cent of the original liquid is obtained as a distillate.

The product resulting from the distillation is then passed over calcium chloride to remove water, or is dried by heating or distilling the turpentine until about 2 per cent of such product has been removed by evaporation.

The product thus substantially freed from the impurities referred to, and water, is ready for further treatment. In this treatment some aluminum chloride is added to the product distilled.

Heating the spruce turpentine with aluminium chloride effects a decomposition of the turpentine, the principal products of the reaction being toluene and propane. The toluene is condensed in the distillate and the gaseous propane conducted to a place of use or is stored for future purposes.

It was found that an increased yield of toluene and propane may be obtained from the distillation of the material in the presence of aluminium chloride by passing a stream of hydrochloric acid gas through the liquid while it is being distilled. The rate of flow of the hydrochloric acid gas passed into the material during the distillation process is not of importance, a slow stream of the gas being sufficient to materially increase the yield of toluene. (1,244,444, Oct. 23, 1917.)

Oxidation of Ammonia.—WALTER S. LANDIS of Niagara Falls, N. Y., patents a process of oxidizing ammonia to nitrose gases. The patent is assigned to Frank S. Washburn of Nashville, Tenn. In previous patents (abstracted in this journal Nov. 1, 1916, p. 539, Patents 1,193,798-99-800 of Aug. 8, 1916) the essential principles governing the successful oxidation of ammonia to nitrose gases were described, and it was pointed out if a high efficiency is to be attained a large excess of air should be mixed with the ammonia before passing the catalyzer. It was also shown that this excess of air rendered it necessary to heat the catalyzers from outside sources in order to keep up the combustion. In this invention the necessity of artificially heating the catalyzers is avoided by enriching the air to be mixed with the ammonia with a quantity of oxygen to make the reaction self-propagating. That is to say, if instead of using atmospheric air containing, say, 20 per cent oxygen and 80 per cent nitrogen, one employs an enriched air containing say 30 per cent to 40 per cent oxygen the catalytic oxidizing reaction becomes self-supporting, even though an excess of air is employed, and the catalyzers need not in such cases be artificially heated, except incidentally or to start the reaction. It has also been found that a convenient method of obtaining this enriched air, is by liquefying atmospheric air, and permitting the nitrogen to boil off until about 40 per cent oxygen or a somewhat higher percentage is left. The ammonia used in this process can be conveniently obtained by treating calcium cyanamid with steam, and the nitrogen boiled off can be conveniently used in the manufacture of said cyanamid. It therefore follows that the waste gases from a liquid-air plant producing nitrogen can be employed to eliminate the necessity of heating the catalyzers after the reaction starts, it being only necessary to raise them to an initial starting temperature, after which the reaction is so strongly exothermic that it will continue of itself. In the use of ordinary air, the concentration of the nitrose gases coming from the catalyzers is often not above 6 per cent to 10 per cent; but by employing an enriched gas, on the other hand, such as that disclosed, concentrations of exit gases of at least double these values are claimed to be easily attained. (1,242,953, Oct. 16, 1917.)

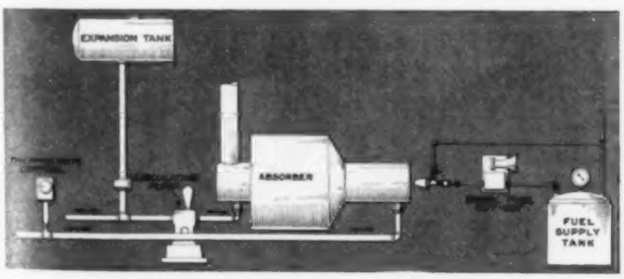
Rensselaer Polytechnic Institute is having extensive additions made to the laboratories of the department of chemistry. Entirely new and complete laboratories will be constructed for quantitative analysis, for organic chemistry and for physical chemistry. Material enlargement will be provided for the food analysis and gas analysis laboratories, and new space assigned for lecture room and recitation room needs. The great increase in number of students entering for the course in chemical engineering has demanded these extensions. Work on the new construction will be started in March, 1918, at which time also ground will be broken for four new dormitories.

An Oil Heating System for Industrial Processes

A system of heat transmission using a mineral oil of high boiling point has been developed by the Merrill Process Company of 70 Devonshire Street, Boston, Mass. The process may be used to increase the fluidity of viscous materials, furnishing heat to ovens, distilling apparatus, heating products which give off inflammable vapors, vulcanizers, melting kettles, calender rolls, etc. The fluid used is called meprolene and is a viscous mineral fluid which is not affected by temperatures up to and somewhat above 600° F. Because of this feature it is possible, when necessary, to obtain working temperatures up to 550° F. with absolute safety as only negligible pressure is created in the system. This is considerably above the possibilities of saturated or superheated steam.

Referring to the diagram, Fig. 1, the circulating heating fluid is supplied to the system from the expansion tank and is circulated through the absorber where the heat is applied by an intense flame from an oil or gas burner. Suitable baffling of the gases assures high heat economy. In general, the burner, if using oil or kerosene, is operated by air pressure. After absorbing the heat transferred to it in the absorber, the fluid passes along to the tank, oven, machine, or whatever form of heat exchanger is being used to transfer its heat. Circulation is accomplished by a positive circulating pump, usually motor driven. Any excess pressure through accident is provided for by properly arranged relief valves. In addition, if, from any cause, the pump ceases to operate, the fuel supply is automatically cut off and an electric warning signal sounded.

If the temperature of the circulating fluid arises beyond a predetermined point, an automatic thermostatic regulator restricts the fuel supply, which permits of a close control at the required temperature. The expansion tank permits expansion, which is negligible, in the



DIAGRAMMATIC ARRANGEMENT OF THE MERRILL PROCESS OF HEAT TRANSMISSION

system due to the heating of the fluid and maintains the pressure at a proper point. The whole system may be closely and positively governed by thermal or electrical control.

Among the applications of the process which have already been developed are those of heating liquids in tanks or vats, operating distilling apparatus where temperatures up to 550° F. are required, in vulcanizing, in japanning and enamelling ovens, and in heating, calendering or finishing rolls. It may be used as an economizer in boiler flue gases. It may also be adopted to prevent the necessity for changing a power plant to provide boilers for furnishing heat that is not required in the form of steam.

Personal

Mr. H. W. ALDRICH, superintendent of the Ladysmith Smelting Corporation, Ladysmith, B. C., has resigned and joined the staff of the Anaconda Copper Mining Co.

Dr. RAYMOND F. BACON, director of the Mellon Institute of the University of Pittsburgh, will be commissioned a lieutenant-colonel in the Ordnance Department of the Army, and will be directed to take charge of the chemical work for our armies in France.

Professor E. BARTOW of the University of Illinois has been commissioned as a major in the Army Reserve Corps. He will go to France to take charge of the sanitary conditions of our army camps.

Mr. FRANK L. ESTEP has resigned as chief engineer of the Tennessee Coal, Iron & Railroad Co., Birmingham, Ala., and on Dec. 1 will become chief engineer of the Nova Scotia Steel & Coal Co., New Glasgow, Nova Scotia. He has been connected with the Tennessee company for the past eight years, first as assistant chief engineer, being promoted to his present position on the resignation of E. J. Best in 1912.

Mr. WILLIAM M. KERR, assistant treasurer of the General Chemical Company and manager of the Philadelphia offices of the company, has been elected a director, to succeed Edward H. Rising, deceased.

Mr. H. GARDNER MCKERROW, for the past two years connected with the textile department of the Marden, Orth & Hastings Corporation of New York, has resigned to take up the management of the textile department of E. F. Drew & Company, Inc., which concern operates oil plants in Philadelphia and other cities. Mr. McKerrow, who is a specialist in coal-tar dyestuffs, textile chemicals and textile oils, will look after that line of work for the Drew interests.

Mr. C. A. MACE has been appointed as the head of the textile department of the Marden, Orth & Hastings Corporation, succeeding H. Gardner McKerrow. Mr. Mace has been for eight years with the Badische organization, at the head of the Chicago offices of the latter concern. He is a graduate of Massachusetts Institute of Technology.

The Michigan Smelting & Refining Co. announces that CHARLES T. BRAGG will take the position of works manager of its Detroit plant January 1, 1918. He has been chemical engineer of the Ohio Brass Co. for six years and was for four years Technical Director of Berry Bros. of Detroit.

Mr. FREDERICK POPE, of Moses, Pope & Messer, Inc., consulting engineers, of New York, has accepted a commission as captain in the Engineer Officers' Reserve Corps, Gas and Flame Division, which is the Thirtieth Engineers.

Mr. GEORGE G. SCHMIDT, formerly engineer for the Metropolitan Street Railway Co., piping engineer for the Pennsylvania Railroad, Belmont Tunnels and the Ashokan Dam and in erection of about fifty industrial plants of national prominence, is now with the Carrier Engineering Corporation as piping engineer. He will be located at the main office, 39 Cortlandt Street, New York.

Mr. THOMAS M. SKINNER, JR., formerly connected with the erection and operation of the Potash Prod-

ucts Co., Alliance, Neb.; The Hord Alkali Products Co., Lakeside, Neb., and the Mid-Continent Chemical Co., Sand Springs, Okla., is now managing the erection of a large chemical plant in Owens Lake, Cal.

Mr. A. Gordon Spencer, formerly chief chemist with the Canadian Inspection and Testing Laboratories, has opened an office as consulting chemist at 618 Transportation Building, Montreal.

Mr. W. F. Trenary, Jr., with headquarters at 419 Brown-Marx Building, Birmingham, Ala., now represents the Harrison Safety Boiler Works of Philadelphia, manufacturers of the Cochrane Heaters and other steam plant appliances, succeeding Mr. W. R. Jennison, whose connection with that company has terminated.

CURRENT MARKET REPORTS

The Iron and Steel Market

It is commonly reported that there has been a large curtailment in pig-iron production, by reason of shortage of Connellsville coke, with a curtailment in steel production resulting from the curtailment in pig-iron production. This is not correct. Fragmentary information, covering only the shortage of Connellsville coke, has been used, and due allowance has not been made for increased quantities of coke available from other districts. The fact that steel-making pig iron cannot be bought in most of the producing districts is taken as support of the conclusion that pig iron production has been greatly restricted.

In ordinary times it might not be worth while to discuss popular fallacies in a semi-monthly market report of this character, but these are new times, bringing both new conditions and a disappearance or restriction of some channels of information usually open, hence it will be necessary in future to do more enlightened guessing and to set up a more vigilant guard against conclusions reached upon insufficient premises. The trade finds a scarcity of material, hears of an insufficient supply of raw material in certain quarters, and observes that the commercial consumption of steel is constantly decreasing. Government requirements in steel, not closely estimable at any time, are assumed to correspond to guesses previously made, the uncertain character of this factor being disregarded, and the conclusion is reached that the production of steel really has suffered a very material curtailment.

Coke Supplies

It is merely an incident that statistics of the supply of coke are currently available only in the case of Connellsville. It is a product which is regularly shipped, not consumed at point of manufacture, and undue importance is attached to the Connellsville figures. The production of coke (exclusive of gas house) in 1916 was 54,533,585 net tons, of which 19,069,361 tons was by-product and 35,464,224 tons beehive. These are Geological Survey figures. The Connellsville Courier's statistics, covering the Connellsville and lower Connellsville region, all beehive, showed 21,654,502 tons. The amount of coke consumed by iron blast furnaces, as reported by the American Iron and Steel Institute, was 44,431,905 tons. Thus the Connellsville region furnished a trifle less than 40 per cent of the country's coke production. In the first nine months of the respective years Connellsville shipments showed a weekly average of 425,000 tons for 1916 and 356,000 tons for 1917, but the country's pig-iron production showed a negligible decrease, the output of by-product coke having continued to increase. From Oct. 20 to Dec. 1 the Connellsville shipments averaged 304,000 tons, or a further decrease of 52,000 tons weekly. The entire decrease would represent only 2,400,000 tons of pig iron a year, but a part of the decrease was undoubtedly in coke for various fuel purposes, for iron foundry use and for other purposes outside the smelting of iron ore, while as to the remainder a part may be assumed to have been balanced by increased output of by-product coke. The balance remaining may have been made up by increased beehive production elsewhere, and probably was. In the circumstances, the monthly steel ingot production statistics, recently undertaken by the American Iron and Steel Institute, will be awaited with particular interest. They are as likely as not to show an increase for November over October.

Government Steel Requirements

The unknown element is the Government tonnage of steel. While various fragmentary pieces of information, perhaps incorrect at that, have leaked out as to Government orders, the concealment of the total lettings has been successfully achieved. An intelligent consideration of what is known leads to the conclusion that war requirements in steel are greatly exceeding the tentative guesses that have been made in recent months. One observes that as far as possible all the shell factories that were operated in 1916 upon shell orders for the Entente Allies are to be put in operation again, that shell orders have been placed in Canada, to use steel from the United States, and that a thoroughgoing and successful search has been made in the United States for other plants that can be converted for the manufacture of shells. Many new plate mills have been built without attendant steel-making facilities, some even without slabbing mills, depending upon blooming mill slabs to be gathered up wherever the steel can be taken from other employment. The merchant shipbuilding program has been speeded up. Large quantities of steel are being used in the manufacture of locomotives and cars for our Allies and for the United States railroad in France. Orders placed for the latter operation now total 980 80-ton Consolidation locomotives, 1004 narrow gauge gasoline locomotives, 30 saddle tank steam narrow gauge locomotives and 22,772 cars of various descriptions, together with at least 165,000 tons of rails. As to various other steel commodities there is more or less information and the balance of probability is that there is much of which nothing at all is known publicly.

There are various reports of individual plants converting from 60 to almost 100 per cent of their output into steel intended for war use. Instead of assuming that these reports are exaggerations or refer to cases in which the participation in war steel production is much above the average, it is better to conclude that there is something in it.

Commercial Demand

Commercial demand for steel has continued to decrease and is apparently very light, for there is little

buying pressure in the open market and specifications on contracts are much lighter than formerly. In view of the large volume of contract business on books they can still be large in tonnage even though light in proportion to the tonnages covered by the contracts. The offerings of finished steel products in the open market are extremely light, but they do not by any means represent all the steel that is really available for sale. Prices are set and when steel is scarce mills prefer to give it to their regular customers, more business being done than is openly reported.

Traffic Conditions

Although the current production of steel is probably equal to the best records of recent months and would therefore be between 5 and 10 per cent in excess of the average production in 1916, it is much less than capacity. Production of both pig iron and steel would have been greater of late had there been sufficient transportation facilities, particularly for the movement of coke. Supplies of coal for by-product coking and for steel mill operation, particularly in the Youngstown district, were inadequate for some time, but in the past fortnight have been very nearly equal to all requirements. The railroad situation is now taken in hand by Congress, following the report of the Interstate Commerce Commission presented Dec. 6, to the effect that the railroads should be permitted to form a general pool or should be taken over by the President. By decision Nov. 24 of the Railroads' War Board, after consultation with various Government departments, the railroads east of Chicago had formed a pool of their physical facilities, to the extent necessary to produce maximum freight movement, and even this operation has helped. Except for such effects as may be produced by winter weather, the production of pig iron and of steel promises to make new records in the next few months.

With only minor and relatively unimportant exceptions market transactions in pig iron, unfinished steel and finished steel products have been at the set prices. The system of control by voluntary agreement between the Government and the producers has worked very well indeed. Difficulties of the buyer are due either to the physical scarcity of the material or to his not having a regular source of supply. The habitual shopper, or "professional buyer" as he is euphoniously dubbed in the trade, has particular difficulty in placing orders at this time.

Non-Ferrous Metal Market

Saturday, Dec. 8.—The metal markets are all inactive and prices are unchanged in practically all cases. Copper remains the same at the Government price. Tin is very scarce and quotations are nominal. Lead is firm at unchanged prices. Spelter is dull and unchanged. Antimony is a trifle higher.

Copper.—Most of the large buyers are engaged on Government work and there is no large market for copper. The prices of 23.50 to large buyers and 24.67½ or 5 per cent above 23.50 for small lots as set by the Government remain.

Tin.—Tin is very scarce and there is practically no change in the spot situation on Straits, which is quoted nominally at 80.00 to 85.00 cents. No. 1 Chinese has been offered at 64.00 cents for prompt delivery. The American Iron and Steel Institute, through its subcommittee on tin, has been placed in control of the tin market by the War Industries Board. It will have charge of imports and distribution. Arrivals in November were very low and this accounts for the scarcity of supplies. The tin in warehouses has been released by the Government subject to distribution by the American Iron and Steel Institute. The London market is very high and £294 per ton has been quoted.

Lead.—The market has been very dull and prices remain at 6.25 cents Trust and 6.25-6.50 outside.

Spelter.—Demand has been very slight and prime Western remains at 7.75 to 8.00 cents. The Government has not yet decided on the regulation of prices, and producers are waiting to see what will be given out as to requirements and prices.

Antimony.—Antimony is quoted at 15.00 to 15.50 cents for Chinese and Japanese. Antimony and its ore will be subject to import license, and the metal has consequently advanced.

Tungsten.—Tungsten is subject to import license and considerable ore shipped from South America will be affected at least temporarily. Sellers are asking $23.00-26.00 for wolframite and $27.00 for schulite.

Molybdenum.—The demand is reported good for early delivery with arrivals slow. Molybdenite is $2.25, with $2.50 quoted for sodium molybdate per pound of Mo.

Chrome.—All grades of chrome ore are very scarce.

Quicksilver.—California has jumped to $115.00 per flask with Mexican Virgin held above $113. Recovered mercury is scarce, with $110 offered.

OTHER METALS

Aluminium, lb.	.36–.38
Bismuth, lb.	3.50
Cadmium, lb.	1.50
Nickel, electrolytic, lb.	.55
Silver, oz.	.85⅝
Platinum, oz.	105.00
Palladium, oz.	125.00

Chemical Market

Coal Tar Products.—There has been more interest shown in these products than in the heavy chemicals, and, owing to the peculiar situation governing toluol, intermediates from that base have been scarce and offered in a restricted manner. Phenol has come in for much attention. The general coal tar situation gives promise of interesting events.

Benzol was the weak feature of the market, with sales reported at low figures, caused by surplus quantities backing up on the market.

Toluol has not been traded in, because of governmental seizure of the product, such business as is passing is in the way of fulfillment of old contracts.

Naphthalene was fairly firm, with offerings restricted and the demand quiet.

Phenol was firm and offerings were much restricted. The governmental authorities have also seized considerable of this product and producers are therefore disinclined to offer.

Benzoate of Soda is firm, with spot stock at a low ebb.

Monorchlorbenzol.—The demand is so slack of late that some producers are not quoting. Offers of quantities at concessions seemingly do not interest buyers.

Metanitraniline.—The demand is not heavy and prices are unchanged.

Aniline Salt.—Buyers are covering only for immediate requirements and concessions are offered for quantities.

Aniline Oil.—There is a somewhat improved tone prevailing, because of heavy buying of late.

Para Toluidine.—The market is firm, with offerings restricted.

Ortho Toluidine.—The production is confined to a few quarters and offerings are restricted, with quotations unchanged.

Tolidin.—Only a few producers are offering at this time, and a firm situation prevails.

Salicylic Acid.—The production has increased and prices are a few cents lower, with the demand slightly subsided.

Gamma Acid.—Several inquiries are in the market, but spot material appears scarce, with a firm position obtaining.

N. & W. Acid.—There does not appear to be a great demand, and prices are unchanged.

Para Amido Phenol.—There is considerable competition, but prices are upheld in fair shape by prices of raw material.

Heavy Chemicals.—As a result of many uncertain factors that have developed concerning the marketing of chemicals at the present time the situation from the sellers' viewpoint is very disappointing at the moment. Soda ash has been added to the conservation list, and this means that licenses will be difficult to secure. Caustic soda having previously been added, the export trade in alkalis is now practically suspended.

Caustic Soda.—As a result of bearish interest which seems to be gathering strength day by day, the market has been subject to a marked drop. As the situation has been in control of second hands for many months, these interests are more inclined to become panicky when a pronounced selling effort appears. From the works, however, there has not been much change. For 1918, 6.60 to 6.65 flat, New York, is quoted, and cannot be shaded much. From second hands holding contracts this figure can be shaded fifteen to twenty points, but the uncertainty of deliveries makes a buyer inclined to go to producers rather than to some of the irresponsible dealers now operating. The courts are full of cases concerning caustic soda deliveries.

Soda Ash.—As a result of a presidential proclamation placing the product on the conservation list, there has been a sharp break in values, particularly for double bags and barrels, which packages have been used for export purposes. Naturally single bags for domestic consumption have weakened somewhat, and there is but little likelihood of any special activity until the market has been readjusted to the new state of affairs.

Bichromate of Soda.—In view of the fact that 1918 contracts are being offered at 16½c., with reports of sales at even lower figures, the spot situation has weakened and offers at 17c. have not found buyers. At least one new producer, and possibly more, are planning a production next year.

Chlorate of Potash.—While the 1918 figure on chlorate has not yet been established, it will probably be under 40c., as against 70c. last year. As a result of this condition there has been a very eager desire to unload chlorate delivered on 1917 contracts, and the market has been in some instances 50 per cent under the contract price, representing a loss of 35c. a pound to the seller.

Cyanide of Soda.—The situation has been very quiet indeed and offers, particularly from out-of-town points, have been made at very low figures, without, however, attracting particular attention.

Sulphuric Acid.—While no one appears to have positive official action concerning the plans of the government, it is generally conceded that the plants will furnish 66 brimstone acid to the government at $28.00, works. Probably the brimstone or the pyrites will be furnished at a certain price and the figure will allow of a fair manufacturing profit. Practically all acid now is of the higher concentration.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, DEC. 7, 1917

Acetic anhydride	lb.	1.90	—	2.00
Acetone, drums	lb.	.36	—	.37
Acid, acetic, 28 per cent	lb.	.05¾	—	.06
Acetic, 56 per cent	lb.	.11¾	—	.12¼
Acetic, glacial, 99½ per cent, carboys	lb.	.40	—	.50
Boric, crystals	lb.	.14	—	.14½
Citric, crystals	lb.	.75	—	.78
Hydrochloric, C.P	lb.	.08¼	—	.08¾
Hydrochloric, 20 deg	lb.	.02⅛	—	.02⅜
Hydrochloric, C.P., conc., 22 deg	lb.	.02¼	—	.02⅝
Hydrofluoric, 30 per cent, in barrels	lb.	.06¼	—	.06½
Lactic, 44 per cent	lb.	.15½	—	.16½
Lactic, 22 per cent	lb.	.06¼	—	.07¼
Nitric, 36 deg	lb.	.06½	—	.07
Nitric, 42 deg	lb.	.09¼	—	.10
Oxalic, crystals	lb.	.45	—	.46
Phosphoric, 47 per cent-50 per cent	lb.	.07½	—	.....
Picric	lb.	.75	—	.85
Pyrogallic, resublimed	lb.	3.15	—	3.25
Sulphuric, 60 deg	ton	25.00	—	30.00
Sulphuric, 66 deg	ton	36.00	—	40.00
Sulphuric, oleum (Fuming), tank cars	ton	60.00	—	.....
Tannic, U. S. P., bulk	lb.	1.30	—	1.35
Tartaric, crystals	lb.	.79	—	.82
Tungstic, per lb. of W	lb.	1.80	—	1.90
Alcohol, sugar cane, 188 proof	gal.	5.20	—	5.40
Alcohol, wood, 95 per cent	gal.	1.20	—	1.22
Alcohol, denatured, 180 proof	gal.	.84	—	.86
Alum, ammonia lump	lb.	.04½	—	.05
Alum, chrome ammonium	lb.	.18½	—	.19
Alum, chrome potassium	lb.	.24½	—	.25¼
Alum, chrome sodium	lb.	.12½	—	.13
Alum, potash lump	lb.	.09¼	—	.09½
Aluminium sulphate, technical	lb.	.02½	—	.03¼
Aluminium sulphate, iron free	lb.	.03½	—	.04
Ammonia aqua, 26 deg. carboys	lb.	.20	—	.21
Ammonium carbonate	lb.	.10	—	.11
Ammonium nitrate	lb.	.18	—	.20
Ammonium, sulphate domestic	lb.	.07⅛	—	7.15
Amyl acetate	gal.	5.25	—	5.40
Arsenic, white	lb.	.16	—	.16½
Arsenic, red	lb.	.50	—	.60
Barium carbonate, 99 per cent	ton	70.00	—	.....
Barium carborate 97-98 per cent	ton	65.00	—	67.00
Barium chloride	ton	85.00	—	90.00
Barium sulphate (Blanc Fixe, powder)	lb.	.03½	—	.04
Barium nitrate	lb.	.10½	—	.11
Barium peroxide, basis 70 per cent	lb.	.27	—	.27½
Bleaching powder, 35 per cent chlorine	lb.	.01½	—	.03
Borax, crystals, sacks	lb.	.07¾	—	.08½
Brimstone, crude	ton	60.00	—	65.00
Bromine, technical	lb.	.65	—	.70
Calcium, acetate, crude	lb.	.06	—	.06½
Calcium, carbide	lb.	.08½	—	.09
Calcium chloride, 70-75 per cent, fused, lump	"	21.00	—	22.00
Calcium peroxide	lb.	1.60	—	1.70
Calcium phosphate	lb.	.30	—	.31
Calcium sulphate	lb.	....	—	.....
Carbon bisulphide	lb.	.07	—	.07½
Carbon tetrachloride, drums	lb.	.15¾	—	.16¼
Caustic potash, 88-92 per cent	lb.	.84	—	.84½
Caustic soda, 76 per cent	lb.	.07¼	—	.08
Chlorine, liquid	lb.	.15	—	.18
Cobalt oxide	lb.	1.40	—	1.50
Copperas	lb.	.01¼	—	.01½
Copper carbonate	lb.	.45	—	.....
Copper cyanide	lb.	.75	—	.78
Copper sulphate, 99 per cent, large crystals	lb.	.09½	—	.09¾
Cream of tartar, crystals	lb.	.55	—	.57
Epsom salt, bags	lb.	.03¼	—	.04
Formaldehyde, 40 per cent	lb.	.19	—	.20
Glauber's salt	100 lb.	.80	—	.85
Glycerine, bulk, C. P.	lb.	.70	—	.71
Iodine, resublimed	lb.	4.25	—	4.35
Iron oxide	lb	.13	—	.15
Lead, acetate, white crystals	lb.	.17½	—	.19
Lead arsenate	lb.	.16	—	.20
Lead nitrate	lb.	.17½	—	.18
Litharge, American	lb.	.09½	—	.11½
Lithium carbonate	lb.	1.50	—	2.00
Manganese dioxide, U. S. P.	lb.	.48	—	.55
Magnesium carbonate, tech	lb.	.09¾	—	.10
Nickel salt, single	lb.	.14½	—	.....
Nickel salt, double	lb.	.11½	—	.....
Phosphorus, red	lb.	1.70	—	.....
Phosphorus, yellow	lb.	2.10	—	2.15
Potassium bichromate	lb.	.45	—	.46
Potassium bromide granular	lb.	1.45	—	1.50

Potassium carbonate calcined, 85-90 per cent	lb.	.75	—	.....
Potassium chlorate, crystals	lb.	.42	—	.44
Potassium cyanide, 98-99 per cent	lb.	Nominal		
Potassium iodide	lb.	2.90	—	3.00
Potassium muriate 80-85 p.c. basis of 80 p.c	ton	330.00	—	345.00
Potassium nitrate	lb.	.28	—	.30
Potassium permanganate	lb.	3.85	—	4.00
Potassium prussiate, red	lb.	2.70	—	3.00
Potassium prussiate, yellow	lb.	1.27	—	1.35
Potassium sulphate, 90-95 p.c. basis 90 p.c	ton	400.00	—	.....
Rochelle salts	lb.	.39	—	.39½
Salammoniac, gray gran	lb.	.15	—	.....
Salammoniac, white gran	lb.	.18	—	.18½
Sal soda	100 lb.	1.15	—	1.25
Salt cake	100 lb.	1.50	—	2.00
Silver cyanide, based on market price of silver	oz.	.....	—	.....
Silver nitrate	oz.	.57	—	.59
Soda ash, 58 per cent. light, flat	100 lb.	2.90	—	3.00
Soda ash, 58 per cent, dense, flat	100 lb.	4.00	—	.....
Sodium acetate	lb.	.14	—	.15
Sodium benzoate	lb.	3.00	—	.....
Sodium bicarbonate, domestic	lb.	.02⅝	—	.03
Sodium bicarbonate, English	lb.	.....	—	.....
Sodium bichromate	lb.	.18½	—	.20
Sodium bisulphite, powd	lb.	.06¼	—	.06½
Sodium chlorate	lb.	.24½	—	.25
Sodium cyanide	lb.	.48	—	.51
Sodium fluoride, commercial	lb.	.18½	—	.....
Sodium hyposulphite	lb.	.....	—	.....
Sodium molybdate, per lb. of Mo	lb.	2.50	—	.....
Sodium nitrate, 95%	100 lb.	4.65	—	4.75
Sodium nitrite	lb.	.30	—	.35
Sodium peroxide	lb.	.55	—	.60
Sodium phosphate	lb.	.04	—	.04½
Sodium prussiate, yellow	lb.	.36	—	.37
Sodium silicate, liquid	100 lb.	1.80	—	2.00
Sodium sulphide, 30 per cent crystals	lb.	.02½	—	.03½
Sodium sulphide, 60 per cent, fused	lb.	.04	—	.04½
Sodium sulphite	lb.	.04	—	.05½
Strontium nitrate	lb.	.35	—	.40
Sulphur chloride, drums	lb.	.06	—	.06½
Sulphur dioxide, liquid, in cylinders	lb.	.15	—	.40
Sulphur, flowers, sublimed	100 lb.	4.05	—	4.10
Sulphur, roll	100 lb.	3.70	—	3.85
Sulphur, crude	ton	60.00	—	65.00
Tin bichloride, 50 deg	lb.	.23¾	—	.24
Tin oxide	lb.	.72	—	.73
Zinc carbonate	lb.	.35	—	.38
Zinc chloride	lb.	.10¼	—	.11
Zinc cyanide	lb.	.50	—	.....
Zinc dust 350 mesh	lb.	.17	—	.18
Zinc oxide, American process XX	lb.	.16	—	.17
Zinc sulphate	lb.	.05½	—	.05¾

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.40	—	.42
Benzol, 90 per cent	gal.	....	—	.....
Toluol, pure water white	gal.	Nominal		
Xylol, pure, water white	gal.	.45	—	.50
Solvent naphtha, water white	gal.	.17	—	.22
Solvent naphtha, crude, heavy	gal.	.13	—	.16
Creosote oil, 25 per cent	gal.	.33	—	.35
Dip oil, 20 per cent	gal.	.29	—	.30
Pitch, various grades	ton	8.00	—	20.00
Carbolic acid, crude, 95-97 per cent	lb.	1.05	—	1.10
Carbolic acid, crude, 50 per cent	lb.	.60	—	.65
Carbolic acid, crude, 25 per cent	lb.	.32	—	.35
Cresol, U. S. P	lb.	.19	—	.20

Intermediates, Etc.

Apha naphthol, crude	lb.	1.10	—	.....
Alpha naphthol, distilled	lb.	1.60	—	.....
Alpha naphthylamin	lb.	.58	—	.60
Aniline oil, drums extra	lb.	.25¾	—	.26
Aniline salts	lb.	.31½	—	.33
Anthracene, 80 per cent	lb.	.50	—	.....
Benzaldehyde	lb.	4.00	—	4.50
Benzidine, base	lb.	1.80	—	1.85
Benzidine, sulphate	lb.	1.40	—	1.50
Benzoic acid	lb.	3.00	—	3.10
Benzyl chloride	lb.	1.75	—	2.00
Beta naphthol benzoate	lb.	7.00	—	8.00
Beta naphthol, sublimed	lb.	.85	—	.90
Beta naphthylamin com	lb.	2.50	—	2.65
Dichlor benzol	lb.	.12	—	.18
Diethylaniline	lb.	3.75	—	4.25
Dinitro benzol	lb.	.34	—	.50
Dinitrochlorbenzol	lb.	.40	—	.42
Dinitronaphthaline	lb.	.55	—	.60
Dinitrotoluol	lb.	.57	—	.62
Dinitrophenol	lb.	.55	—	.57
Dimethylaniline	lb.	.60	—	.65
Diphenylamine	lb.	1.00	—	.....
H-acid	lb.	3.00	—	3.50
Metaphenylenediamine	lb.	1.75	—	1.80
Monochlorbenzol	lb.	.19	—	.22
Naphthalene, flake	lb.	.09½	—	.10
Naphthalene, balls	lb.	.10½	—	.10¾
Naphthionic acid, crude	lb.	1.50	—	1.75
Naphthylamin-di-sulfonic acid	lb.	1.00	—	1.10
Nitro naphthaline	lb.	.45	—	.50
Nitro toluol	lb.	.50	—	.55
Ortho-amidophenol	lb.	....	—	....
Ortho-toluidine	lb.	.90	—	1.00
Orth-nitro-toluol	lb.	.75	—	1.00
Para-amidophenol, base	lb.	4.50	—	5.00
Para-amido-phenol, H. Ch	lb.	5.25	—	5.75
Paranitraniline	lb.	1.10	—	1.15
Para-nitro-toluol	lb.	1.50	—	1.60
Paraphenylenediamine	lb.	3.50	—	4.00
Para toluidine	lb.	2.25	—	.....
Phthalic acid anhydride	lb.	6.30	—	6.40
Phenol, U. S. P	lb.	.52	—	.53
Resorcin, technical	lb.	8.00	—	9.00
Resorcin, pure	lb.	13.00	—	13.50
Salicylic acid	lb.	1.28	—	1.30
Salol	lb.	1.85	—	2.00
Sulphanilic acid	lb.	.32	—	.35
Tolidin	lb.	2.50	—	.....
Toluidine-mixture	lb.	.75	—	.85

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	3.50	—	....
Corning, Ohio	bbl.	2.60	—	....
Somerset, Ky	bbl.	2.40	—	....
Wooster, Ohio	bbl.	2.38	—	....
Indiana	bbl.	1.98	—	....
Illinois	bbl.	2.12	—	....
Oklahoma and Kansas	bbl.	2.00	—	....
Caddo, La., light	bbl.	2.00	—	....
Corsicana, Tex., light	bbl.	2.00	—	....
California	bbl.	.98	—	1.32
Gulf Coast	bbl.	1.00	—	....

Fuel Oil

New York	gal.	.11	—	.....
Pittsburgh	gal.	.07½	—	.10
Oklahoma-Kans	bbl.	.70	—	1.55
Texas	bbl.	1.50	—	1.75
Los Angeles	bbl.	1.45	—	.....
San Francisco	bbl.	1.45	—	.....

Gasoline (Wholesale)

New York	gal.	.24	—	.....
Boston	gal.	.25	—	.....
Pittsburgh	gal.	.26	—	.....
Chicago	gal.	.21	—	.....
Oklahoma	gal.	.23	—	.....
San Francisco	gal.	.20½	—	.....

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.13½	—	.14
Cylinder, light	gal.	.21	—	.26
Cylinder, dark	gal.	.18	—	.19
Paraffine, high viscosity	gal.	.29½	—	.30
Paraffine, .903 sp. gr	gal.	.21½	—	.22
Paraffine, .865 sp. gr	gal.	.18½	—	.19

Flotation Oils

(Prices at New York unless otherwise stated)

Pine oil, crude, f.o.b. Florida	gal.	.44	—	....
Pine oil, steam distilled, sp. gr. 0.925-0.940	gal.	.50	—	.....
Pine oil, destructively distilled	gal.	.43	—	.53
Pine-tar oil, sp. gr. 1.025-1.035	gal.	.30	—	.....
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.35	—	.....
Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	—	.....
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.26	—	.....
Pine tar, thin, sp. gr. 1.060-1.080	gal.	.32	—	.....
Turpentine, crude, sp. gr. 0.980-1.000	gal.	.40	—	.....
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	.21	—	.....
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.19½	—	.....
Wood creosote, ref. f.o.b. Florida	gal.	.30½	—	.....

Vegetable and Other Oils

China wood oil	lb.	.22	—	.23
Cottonseed oil, crude	gal.	1.24	—	.....
Linseed oil, raw, cars	gal.	1.20	—	.....
Peanut oil, crude	gal.	1.30	—	.....
Rosin oil, first run	gal.	.35	—	.....
Rosin oil, fourth run	gal.	.66	—	.....
Soya bean oil, Manchuria	lb.	.17¼	—	.17½
Turpentine, spirits	gal.	.50	—	.51

Miscellaneous Materials

Barytes, floated, white, foreign	ton	40.00	—	50.00
Barytes, floated, white, domestic	ton	30.00	—	36.00
Beeswax, white, pure	lb.	.56	—	.64
Carnauba wax, flor	lb.	.67	—	.....
Casein	lb.	.22	—	.30
Chalk, light, precipitated, English	lb.	.....	—	.....
Feldspar	ton	8.00	—	12.00
Fuller's earth, powdered	100 lb.	1.00	—	1.50
Ozokerite, crude, brown	lb.	.65	—	.75
Ozokerite, American, refined, white	lb.	.75	—	1.00
Red lead, dry, carloads	lb.	.10	—	.11¼
Rosin, 280 lb.	bbl.	7.20	—	.....
Soapstone	ton	10.00	—	12.50
Talc, American, white	ton	15.00	—	22.00
White lead, dry	lb.	.09	—	.10

Refractories, Etc.

(F.O.B. Works)

Chrome brick	net ton	Nominal		
Chrome cement, Grecian	net ton	Nominal		
Clay brick 1st quality fireclay	per 1000	50.00	—	55.00
Clay brick, second quality	per 1000	35.00	—	40.00
Magnesite, raw	ton	30.00	—	35.00
Magnesite, calcined	ton	40.00	—	55.00
Magnesite, Grecian, dead burned	net ton	85.00	—	90.00
Magnesia brick, Grecian, 9x4½x2½	net ton	135.00	—	140.00
Silica brick	per 1000	50.00	—	60.00

Ferroalloys

Ferrocarbontitanium, 15-18 per cent, carloads, f.o.b. Niagara Falls, N. Y	ton	100.00	—	....
Ferrochromium, per lb. of Cr	lb.	40	—	.45
Ferromanganese, domestic,	ton	250 00	—	.....
Ferromanganese, English	ton	325.00	—	....
Ferromolybdenum, per lb. of Mo	lb.	5.00	—	.....
Ferrosilicon, 75 per cent, f.o.b. N. Y	ton	.....	—	.....
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh	ton	160 00	—	.....
Ferrosilicon, 50 per cent, contract	ton	100.00	—	175.00
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	2.35	—	.....
Ferrouranium, f.o.b. works, per lb. of U	lb.	7.00	—	7.50
Ferrovanadium, f.o.b. works	lb.	3.25	—	3.50

Ores and Semi-finished Products

Antimony ore, per unit		1.60	—	1.75
Chrome ore, 48 per cent minimum, f.o.b. Cal., per unit	ton			.90
Manganese ore, 48 per cent and over, per unit	ton			1.20
Manganese ore, chemical	ton	80.00	—	100.00
Molybdenite, per lb. of MoS_2	lb.	2.15	—	2.25
Tungsten, Scheelite, per unit of WO_3	ton	27.00	—	.....
Tungsten, Wolframite, per unit of WO_3	ton	23.00	—	26.00
Uranium oxide, 96%	lb.	3.25	—	3.60
Vanadium Pentoxide, 99%	lb.			10.50
Pyrites, foreign	unit	.16	—	.16½
Pyrites, domestic	unit	.20	—	.....

INDUSTRIAL

Financial, Construction and Manufacturers' News

New Companies

The Acme Brass Foundry Company, Pittsburgh, Pa. Capital, $25,000. To operate a local plant. H. I. Wasserstrom, treasurer.

The Allied Chemical Works, Inc., New Orleans, La. Capital, $30,000. To operate a plant for the production of bicarbonate of soda, potash, and other chemicals from hardwood ashes. Incorporators: W. T. King, Donaldson Caffery and Judge Dormon, New Orleans.

The American Cellon Company, Newark, N. J. Capital, $1 000 000. To manufacture chemicals and allied products. Incorporators: Charles B. Copeland, East Orange; Frederick N. Canfield, Charles Hollander, Bronx; John Heiss, Jr., Belleville; A. Rolleri and Joseph A. Weiss, Newark.

The Ash Iron Company, Duluth, Minn. Capital, $500,000. To engage in the production of iron products. Incorporators: Walter B. Congdon, James Wanless and Charles A. Humbert, Duluth; David T. Adams, Chicago, Ill., and K. Todd, St. Paul, Minn.

The Batavia Steel Products Corporation, New York. Capital, $1,000,000. To engage in the production of steel products. Incorporators: George V. Reilly, S. B. Howard and A. W. Britton, 65 Cedar Street, New York.

The Black Hawk Gold Company, Dover, Del. Capital, $5,000,000. To mine for gold.

Blenio, Inc., Washington, D. C. Capital, $200,000. To manufacture fireproofing and waterproofing paints. Incorporators: John W. Dawson, New York; Robert C. Hotson, Westminster, Md., and T. T. Ansberry, Washington.

The Blueridge Chemical Corporation, Rocky Mount, Va. Capital, $150,000. To engage in the manufacture of chemicals and allied products. Incorporators: W. C. Menefee and A. S. Adams.

J. G. Brown, Inc., New York. Capital, $25,000. To manufacture chemicals. Incorporators: T. F. Thornton, D. R. Bernstein and J. G. Brown, 48 Post Avenue.

Brown-Ferrer, Inc., Plainfield, N. J. Capital, $50,000. To operate a local plant for the manufacture of chemicals. Incorporators: G. Clement, John S. Johnston and Louis A. Clement, Plainfield.

The Chicago Montana Manganese Company, Dover, Del. Capital, $300,000. To manufacture and deal in iron and manganese products. Incorporators: C. L. Rimlinger and M. M. Clancy, Wilmington; C. M. Egner, Elkton, Md.

The Commercial Chemical Company, Memphis, Tenn. Capital, $15,000. To manufacture chemicals and kindred products. Incorporators: W. C. Pryor, Robert H. Stickley and S. D. Tucker.

The Coolrite Company, Ithaca, N. Y. Nominal capital, $5,000. To manufacture coolrite and chemical products. Incorporators: A. W. Browne, G. F. Simpson and N. Hanford, Ithaca.

The Corning Foundry Company, Corning, N. Y. Capital, $100,000. To operate a local plant. Incorporators: S. E. Flitner, W. N. Gurnsey and B. W. Wellington, Corning.

The Crescent Ink & Color Company, New York. Capital, $100 000. To manufacture ink and colors. Incorporators: N. A. McManus and A. and J. Alexander, 495 West End Avenue.

The Diamantine Chemical Company, Monessen, Pa. Capital, $100 000. To manufacture chemicals and allied products. Incorporators: Peter Lucarakis and George Stefanides, Monessen, and M. J. Dain, Pittsburgh.

The Electro Products Company, Wilmington, Del. Capital, $500 000. To manufacture machines under electrolytic, chemical and other processes. Incorporators: L. A. Irwin, N. L. Rogers and Harry W. Davis, Wilmington.

The Fuelite Corporation, New York. Capital, $50,000. To manufacture compounds, chemicals, preparations and materials for the treatment of coal, coke, etc. Incorporators: Albert R. Bremer, E. A. and C. Alexander, Yonkers.

The Fyr-Fyter Sales Company of New York, Inc., New York. Capital, $15,000. To manufacture and deal in fire-escapes and chemical compounds. Incorporators: H. R. Ismon, L. A. Birck and W. D. Forster, 120 Broadway.

E. D. Giberson & Company, New York. Capital, $50,000. To manufacture iron and steel products. Incorporators: E. D. and M. F. Giberson and R. D. Whiting, 310 Wadsworth Avenue.

The Goldsmith Brothers Smelting & Refining Company of Georgia, Atlanta, Ga. Capital, $10,000. To operate a local plant. Incorporators: Frank H. Leslie, Atlanta, and L. L. Lewis, Chicago, Ill.

The Great Eastern Paper Company, Bangor, Me. Capital, $1,200,000. To manufacture paper of all kinds. Incorporators: Garret Schenck and Charles W. Mullen.

The H. & H. Foundry Company, Stamford, Conn. Capital, $15,000. To operate a local plant. Incorporators: C. P. Webb, N. Rominello, Benjamin Harris, Stamford, and John Hanson, Greenwich.

The Hartland Chemical Company, Hartland, W. Va. Capital, $10,000. To manufacture chemicals and allied products. Incorporators: D. G. Price and R. M. French, New York; J. A. Jones and O. L. Hall, Clay, W. Va.; R. E. Light, Hartland, W. Va.

The Hercules Electric Steel Corporation, New York. Capital, $50 000. Incorporators: W. L. Scott, A. Heller and W. H. Rich, 110 Liberty Street.

Hollingshurst & Company, New York. Active capital, $10,000. To operate a plant for the manufacture of fertilizers. Incorporators: J. K. Byard, B. O. Graves and M. Spalletta, 120 Broadway.

The Howells Metallurgical Company, Pittsburgh, Pa. Nominal capital, $5,000. T. J. Howells is the principal incorporator.

The Iler Foundry & Manufacturing Company, Columbus, Ohio. Capital, $30,000. To operate a local plant. Incorporators: Elmer E. Cordrey and F. M. Iler, Columbus.

The Keystone Graphite Company, Ashland, Ala. Capital, $150,000. To develop graphite properties. Incorporators: W. W. Bromelsick, A. A. Allen, A. V. Calkins and W. A. Kitchins, Ashland.

The Marland Chemical Company, Ponca City, Okla. Capital, $100,000. To operate a plant for the manufacture of chemicals and allied products. Incorporators: E. W. Marland, J. S. Alcorn and A. L. Bogan.

The National Aniline & Chemical Company, Jersey City, N. J. Capital, $18 959,500. To manufacture chemicals and kindred specialties. Incorporators: J. F. Stone, W. W. McIlray and W. Becker, all of New York.

The National Potash Company, Omaha, Neb. Capital, $500,000. To engage in the manufacture, production, refining and sale of potash. Incorporators: W. P. Haubach, F. A. Waldmann and John B. Potts, Omaha.

The National Reduction Corporation, New York. Capital, $1,100,000. To manufacture turpentine, charcoal and tar, etc., from wood. Incorporators: James H. Kirkpatrick and G. V. Ferguson, New York; Park L. Woodward, Great Kills, S. I.

The Nevin Chemical Company, St. Louis, Mo. Capital, $200,000. To manufacture chemicals, etc. Incorporators: P. Fahle, R. C. and M. J. Hart and Vincent Dempsey, St. Louis.

The Northwest Chemical Company, Spokane, Wash. Nominal capital, $5,000. To manufacture chemicals and sanitary supplies.

The Occidental Chemical Company, Oakland, Cal. Capital, $350,000. To manufacture chemicals and potash specialties. The company will take over and operate the California Chemical Company, Santa Barbara. Incorporators: F. A. Williamson, George H. Morse, H. H. Collier, C. C. Watts and H. G. Tardy, Oakland.

John Opitz, Inc., New York. Capital, $200,000. To manufacture chemicals and allied products. Incorporators: C. J. Opitz, 183 East 143d Street; H. Napretek and H. R. Opitz, Blissville, N. Y.

The Otis Phosphate Company, Benotis, Fla. Capital, $50,000. To operate a phosphate works. Incorporators: James F. Meredith, Fort Myers, Fla.; Otis E. Meredith and B. F. Meredith, Benotis.

The Pacific Reduction & Chemical Company, Tenino, Wash. Capital, $500,000. To operate a smelting works, including a plant for the manufacture of coal briquettes. Incorporators: H. P. Scheel and William McArthur, Tenino, and F. M. Lane, Tacoma, Wash.

The Peach Kaolin Company of Delaware, Philadelphia, Pa. Capital, $50,000, with Delaware charter. To manufacture clay products, etc. Incorporators: Carl N. Martin and J. Elliott Newlin, Philadelphia.

Peper Brothers, Inc., Brooklyn, N. Y. Capital, $35,400. To manufacture chemicals, paints and dyes. Incorporators: G. and W., and J. W. Peper, 321 Caton Avenue, Brooklyn.

The Piedmont Pyrites & Mineral Corporation, Madison, Va. Capital, $50,000. To operate a local works for pyrites production, etc. Principal incorporator: J. W. Price.

The Pioneer Oil Refining Company, Bowling Green, Ky. Capital, $100 000. To construct and operate an oil refining plant at Rodimer, Ky. Incorporators: A. Laurie, Toledo, Ohio; L. W. Searles, Birmingham, Ala.; Benjamin H. Briggs, Frankfort, Ky.

The Pioneer Paper Company, Olympia, Wash. Capital, $75,000. To manufacture paper of all kinds.

The Peoples Mutual Lead & Zinc Company, Muhall, Okla. Capital, $1,000,000. To engage in a general mining business. Incorporators: G. M. and W. C. Wolfe and Thurman Ellison, Mulhall.

The Precision Glass Apparatus Company, New York. Capital, $25,000. To manufacture glass apparatus of various kinds. Incorporators: J. C. Foley, L. M. Melchior and W. H. Muncey, 237 East Forty-first Street, New York.

The Premier Rubber Company, Jersey City, N. J. Capital, $100,000. To manufacture rubber goods. Incorporators: A. M. Lowenthal, C. L. Williams and William Lowenthal, all of New York.

John R. Proctor, Inc., 721 Broadway, Bayonne, N. J. Capital, $30,000. To manufacture rubber and metal goods. Incorporators: John R. Proctor and Lewis L. Ransom, Bayonne.

The Radium Chemical Company, Chicago, Ill. Capital, $25,000. To manufacture chemicals and allied products.

The Richvale Steel Company, New York. Capital, $1,000 000. To manufacture steel products and engage in a general mining business. Incorporators: S. B. Howard and A. W. Britten, 65 Cedar Street.

W. B. Scaife & Sons Company, Pittsburgh, Pa. Capital, $850,000. To engage in a general iron and steel business. Incorporators: William B. and J. V. Scaife and M. M. Frey, Jr., Pittsburgh.

The Seneca Paper Company, Geneva, N. Y. Capital, $10,000. To manufacture paper products. Incorporators: P. H. Sheehan, L. Compton and W. P. O'Malley, Geneva.

The Smithers Chemical Company, St. Louis, Mo. Capital, $10,000. To manufacture chemicals. Incorporators: John H. Smithers, F. E. Walsh, John L. Brandt and W. R. Joyce.

The St. Louis Oil & Refining Company, St. Louis, Mo. Capital, $250 000. To construct and operate an oil refining works. Incorporators: R. H. Macon, J. L. English and W. B. Harrison, St. Louis.

The Stratford Chemical Works, Newark, N. J. Capital, $250,000, with Delaware charter. Incorporators: W. A. Keener, Newark, and S. Weitzenbluen, New York.

The Tar Heel Manganese Company, Mount Airy, N. C. Capital, $100,000. To engage in a general manganese mining business.

Tuhoy & Lounsbury, Inc., Pennsgrove, N. J. Capital, $25,000. To manufacture chemicals and kindred products. Incorporators: James L. Tuhoy, Harry Lounsbury and M. Tuhoy, Pennsgrove; Charles W. Lounsbury, Salem.

The Union Chemical Company, Memphis, Tenn. Capital, $25,000. To manufacture chemicals. Incorporators: C. M. Jones, E. W. Jones, C. Barnum and T. F. Finley, Memphis.

The United American Metals Corporation, Brooklyn, N. Y. Capital, $500,000. To engage in a general manufacturing and smelting of metals. Incorporators: R. L. Gray, J. A. Burns and G. K. Wilson, 82 Washington Place, New York.

The United States Industrial Chemical Company, Baltimore, Md. Capital, $24,000,000. To operate a plant at Curtis Bay for the manufacture of chemicals, fertilizers, etc.

The United States Potash Products Company, White Plains, N. Y. Capital, $5,500,000, with Delaware charter. To man-

ufacture potash specialties. Incorporators: D. T. Connet, White Plains; J. F. Roach and C. E. Bahn, New York.

The UNIVERSAL GLASS COMPANY, New Kensington, Pa. Capital $100,000. To manufacture glass of all kinds. Incorporators: C. A. and F. Bloser and H. W. Killian, New Kensington.

The VIRGINIA MANGANESE MINING CORPORATION, Attaway, Va. Capital, $50 000. To develop manganese properties in Virginia. Incorporators: J. W. Ruff and J. L. Phillips, Attaway.

The VITRUMUS COMPANY, Norfolk, Va. Capital, $975,000. To construct and operate a fertilizer manufacturing plant. Principal incorporator: R. W. Gamble, Norfolk.

OTTO P. WEISSWANGE, INC., Mt. Vernon, N. Y. Capital, $50,000. To manufacture precision thermometers and scientific glass apparatus. Incorporators: M. Hertz, H. Weissmann and E. K. Noll, 44 Court Street, Brooklyn.

The YOUNGSTOWN PRESSED STEEL COMPANY, Youngstown, Ohio. Capital, $1,000,000. To manufacture pressed steel, metal lath and kindred specialties. Incorporators: C. A. Manchester, P. J. Jones, R. A. Henderson and Franklin B. Powers, Youngstown.

Construction and Operation

Alabama

BIRMINGHAM.—The Crystalline Flake Graphite Company, 1901 First Avenue, recently incorporated with a capital of $100,000, is planning for the erection of a large plant at Ashland for the development of 236 acres of graphite lands. A. F. Loventhal, Birmingham, is the president and manager of the new company.

BIRMINGHAM.—Fire recently destroyed the plant of the Indian Refining Company, Avenue E and Thirty-second Street, Avondale, near Birmingham, with loss estimated at approximately $125,000. The company is making plans for the immediate rebuilding of the plant, to include the erection of a large warehouse and other buildings. F. A. Chapman is manager.

California

LOS ANGELES.—The American Can Company, Forty-eighth Street and Santa Fe Avenue, Vernon, has filed plans for the erection of a new addition, about 125 x 395 feet. The company recently acquired property adjoining the present works, and is planning for the construction of extensions, to cost approximately $1,100,000. The capacity of the works will be increased to about 2,000,000 cans daily. C. J. Gordon is the local sales manager.

LOS ANGELES.—The Los Angeles Shipbuilding & Drydock Company is planning for the construction of two new shipways, with necessary shop structures, at its shipbuilding works at Smith's Island, Wilmington. The company has been awarded a contract by the Emergency Fleet Corporation for the construction of ten new steel ships, with capacity of about 8,800 tons.

MARTINEZ.—The Butters Chemical Company is making rapid progress in the construction of a new zinc reduction plant. Work has been commenced on the initial unit of the works, which will be located on property recently acquired from William Peyton.

MONTEBELLO.—The Standard Oil Company has acquired forty acres of land west of the city as a site for the construction of an oil pumping plant. Forty oil storage tanks will be built and an 8-inch pipe line will be laid to the company's refinery at El Segundo.

SACRAMENTO.—The Southern Pacific Railroad is planning for the immediate construction of a large steel manufacturing plant to have capacity of about 150 tons daily, to cost about $500,000. The company will also build a new switch plant to cost $60,000, and a works for the manufacture of crossing frogs and similar apparatus.

Connecticut

WATERBURY. — The American Brass Company, Washington Street, has awarded a contract for the construction of a new one-story brick and steel addition to its plant, about 42 x 51 feet. Chatfield & Chatfield, Waterbury, are the contractors.

WINDSOR LOCKS.—The E. Horton & Son Company, manufacturer of lathe chucks and castings, is making rapid progress in the construction of a new two-story addition to its plant, about 40 x 50 feet.

Florida

PENSACOLA.—The Pensacola Fertilizer & Oil Company has commenced the construction of its proposed new plant at Grassy Cove, to be devoted to the manufacture of fertilizer and oil from menhaden, a small fish found in abundance in the Gulf waters. The plant includes the construction of a dock 250 feet long, and two large factory buildings will be erected, which will form the first unit of the works. When completed, the plant will consist of seven large buildings, and will be the largest fish and oil factory on the Gulf coast. W. U. Erbine, superintendent of the company, is in charge of the construction work.

Illinois

CHICAGO.—The Chicago Stove & Range Company, South Clark Street, has commenced the construction of a new two-story plant, 50 x 200 feet, at Benton Harbor, Mich. J. E. Fitzgerald is president.

CHICAGO.—The Fitzpatrick Brothers Soap Company, 1319 West Thirty-second Place, is building a new soap factory, two, three and four-story and basement, at a cost of about $90,000. Stressenreuter Brothers, 3020 South Halsted Street, Chicago, are the contractors.

CHICAGO.—The Liquid Carbonic Company, Thirty-first and Kedzie Avenue, has had plans prepared for the construction of a new one and one-half story addition to its plant, about 60 x 100 feet.

EAST ST. LOUIS.—The American Coke and Chemical Company, through one of its subsidiaries, will erect a $10,000,000 by-product coke plant at East St. Louis.

ROCK ISLAND.—The Rock Island Plow Company is making rapid progress in the construction of a new one-story addition to its plant on Second Avenue, about 66 x 235 feet. Estimated cost of the structure is $20,000.

SOUTH BARTONVILLE.—The Keystone Steel & Wire Company is making rapid progress in the erection of a two-story addition to its plant, about 120 x 150 feet, to cost $35,000.

Kansas

BAXTER SPRINGS.—The St. Louis Lead & Zinc Company has acquired forty acres of land about two miles south of Baxter Springs, and is planning for the immediate construction of a new 250-ton mill for the mining of ore.

DOUGLASS.—The Liberty Pipe Line & Refining Company has acquired property on the Hiram Haver farm as a site for the construction of a large oil refinery and pipe line to connect with the A-1 fields.

BUTLER.—John M. Alexander, Lincoln, Neb., has announced that all arrangements have been completed for the organization of a new company, to be known as the Reliance Refinery Company. Plans have been perfected for the construction of a new 1,500-barrel refinery on the Piper farm, just north of El Dorado, and it is expected that work will be commenced within a short time.

Louisiana

HARVEY.—Swift & Company, Chicago, have awarded contracts for the erection of their proposed new sulphuric acid plant at Harvey, near New Orleans. The new factory will supply the company's fertilizer plant with sulphuric acid, which heretofore has been purchased in the open market. The works will have a capacity of sixty tons of acid daily, and the buildings, with necessary equipment, are estimated to cost $250,000.

Maine

MECHANIC FALLS.—Fire recently destroyed the plant of the Colonial Paper Company, a three-story brick structure, with loss estimated to be about $40,000.

Maryland

BALTIMORE.—Reus Brothers, 146 West Mount Royal Avenue, are planning for the construction of a new machine shop on property, recently acquired, adjoining their plant. The company will also install a new ignition department for repair and maintenance work for automobile systems.

BALTIMORE.—The American Propeller & Manufacturing Company will build a new one-story factory, about 150 x 200 feet, at its plant on East Hamburg Street. The structure is estimated to cost about $60,000. Contracts have been awarded.

BALTIMORE.—The United States Industrial Alcohol Co. is reported to be planning for extensions to its plant to double the capacity. The company will extend its bulkhead line around Flood's Point, which will create several additional acres of land now under water.

Massachusetts

SPRINGFIELD.—The Harley Company is completing the erection of a new shop addition to its plant to be used for drop forge work. The structure, with adjoining warehouse, will be 180 x 400 feet, costing about $100,000.

SPRINGFIELD.—The Springfield Glazed Paper Company is planning for the erection of an addition to its plant.

Michigan

GRAND RAPIDS.—The Imperial Chemical Company, manufacturer of chemicals, is planning for the construction of a large addition to its plant on Ann Street, to provide for the constantly increasing demand for its products. The company recently filed notice of an increase in its capitalization from $100,000 to $200,000. Walter Ioor is president and treasurer of the company.

Missouri

ST. LOUIS.—The Bulls Manufacturing Company, 1122 South Twelfth Street, manufacturer of corrugated paper, is having plans prepared for the construction of a new one-story brick factory, about 153 x 380 feet, to cost $100,000, to be erected on Calvery Avenue, between Slevin and Brown Avenues. Will Levy, 1815 Wright Building, St. Louis, is the architect.

KANSAS CITY.—The Oxygen Gas Company, Traders Building, has had revised plans prepared for the erection of a new one-story and basement plant, about 44 x 102. The structure is estimated to cost $60,000. Keene & Simpson, Reliance Building, Kansas City, are the architects.

Nevada

ELKO.—The Standard Oil Shale Company is planning for the immediate erection of a large new 100-ton distilling plant on a tract of land acquired, about 4,260 acres, for the extraction of gasoline and greases from Nevada shale. The works are estimated to cost about $100,000. Headquarters of the company are at Salt Lake City, Utah. K. O. Day is president.

New Hampshire

MANCHESTER.—The Manchester Foundry Company is planning for the immediate erection of five large new additions to its works to provide for increased capacity. George A. Leighton is head of the company.

New York

NEW YORK.—The Aetna Explosives Corporation, Inc., 120 Broadway, will enlarge its plants for the manufacture of 18,000,000 pounds of trinitrotoluol and 12,000,000 pounds of picric acid for the Government.

NEW YORK.—The American Agricultural Chemical Company, 2 Rector Street, has acquired about 3,400 acres of phosphate land near Boyette, in Hillsborough County, Fla. The company is planning the construction of a large fertilizer factory and an acid phosphate manufacturing plant near Tampa, to cost about $1,000,000.

BROOKLYN.—The Brooklyn Union Gas Company, 176 Remsen Street, has taken out building permits for the construction of two two-story brick gas plants, each about 38 x 45 feet, on Smith Street, near Fifth Street. The structures will cost $20,000.

BROOKLYN.—Fire recently destroyed a portion of the plant of the Knowles-Bradley Manufacturing Company, with loss estimated at about $75,000. The company was working on a Government contract for the manufacture of saltpeter.

GENEVA.—The Seneca Paper Company is planning for the establishment of a large plant on a local site under consideration. This company is connected with the Compton Manufacturing Company of Rochester, and it is reported that the Compton Company is planning for the removal of its plant to this location.

DEPEW.—Arrangements have been completed for the Government to take over and operate the large plant of the American Car & Foundry Company. The factory will be devoted to the manufacture of shells exclusively.

NIAGARA FALLS, N. Y.—W. Ralston & Company, Ltd., Whirlpool Street, manu-

facturers of waterproof paper, have had plans prepared for the construction of a new one-story factory building, about 36 x 120 feet. The Allen Smith Company, 327 Fifth Street, is the architect.

LOCKPORT.—Fire, on December 2, destroyed a portion of the plant of the Lockport Paper Company, Mill Street, with loss estimated at about $20,000. The company is planning to install small dynamos temporarily to keep the mill running until the large dynamos can be installed. Wallace I. Keep is head of the company.

Ohio

AKRON.—The Amazon Rubber Company, East Market Street and Massillon Road, is making rapid progress in the construction of a new one-story factory on Britton Road. The new structure is to provide for increased capacity, and is about 60 x 70 feet.

CLEVELAND.—The Acorn Refining Company, 8205 Franklin Avenue, is planning for the construction of a new factory and storage building at its plant. The structure will be two-story, about 60 x 86, and will cost $30,000.

CLEVELAND.—The Manufacturers Oil & Grease Company has acquired property at Junction Road, S. W., and the Big Four tracks, about 400 x 500 feet, and is planning for the erection of a large new factory.

URBANA.—The Central Glass Company is making rapid progress in the alteration and improvement of the plant of the former Eagle Glass Company, and it is expected to inaugurate operations at an early date.

YOUNGSTOWN.—The Ft. Smith Spelter Company has acquired a large rolling mill plant at Greencastle, Inc., and is planning for the organization of a large new $1,000,000 corporation, for the purpose of constructing a sheet zinc manufacturing plant of ten mills. It is planned to supply the new works with raw material in the form of slab zinc from the Ft. Smith spelter plant at Ft. Smith, Ark. D. W. Kerr, Youngstown, is president of the company.

ZANESVILLE.—The Dresden Paper Mills are making rapid progress in the construction of a large new addition to its plant. The structure will be about 45 x 130 feet, and is to provide for increased capacity. Handshy & Son, Zanesville, are the contractors.

Oklahoma

ENID.—The Oil State Refining Company has awarded contracts for the erection of a large 2,500-barrel refinery, and the company is planning to inaugurate operations in the first unit of the plant in about 100 days. The plant will then have a capacity of about 1,000 barrels daily.

LAWTON.—Fire recently destroyed the plant of the Temple Cotton Oil Company, with loss estimated at about $55,000. E. L. Richardson is president and manager.

HENRYETTA.—Work has been started on the construction of the new refinery for the Neupro Refining Company, which will be one of the largest in this section of the state. The plant is being erected at a cost of about $80,000. It is expected to inaugurate operations about March 1.

Pennsylvania

HEIDELBERG.—Fire on December 5 completely destroyed the chemical manufacturing plant of the Aetna Chemical Company, near Pittsburgh.

PHILADELPHIA.—The M. Kardon Paper Company has had plans prepared for the construction of a new one-story brick and steel addition to its plant on 224 Pine Street, about 40 x 115 feet. Herman H. Kline, Sixth and Mifflin Streets, Philadelphia, is the architect.

PHILADELPHIA. — Fire recently destroyed a portion of the glass manufacturing plant of Gill & Company, York and Thompson Streets, with loss estimated at $10,000. It is said the works will be immediately rebuilt.

PHILADELPHIA.—The Penn Chemical Company is completing extensive improvements in its local plant. The company is now building a one-story addition to cost about $25,000.

PHILADELPHIA. — The Tacony Ordnance Company, Tacony, near Philadelphia, has had plans prepared for the construction of a new two-story brick laboratory building, about 25 x 37 feet.

SHARON.—Extensive improvements are now in progress at the Carnegie Steel Company plant, and new ore bins, ore bridges and other extensions will also be erected. Plans have been prepared for the enlargement of blast furnaces Nos. 2 and 3, to increase the present capacity to from 500 to 600 tons daily.

Rhode Island

PROVIDENCE. — The Stillman White Foundry Company has had plans prepared for the erection of a new two-story addition to its plant, about 26 x 40 feet.

South Dakota

LEAD.—The Homestake Gold Mining Co., of South Dakota, has placed an order with the Hardinge Conical Mill Co. for an 8-ft. conical ball mill. This mill will work in conjunction with the stamps of that company, which now has over 1000 stamps in daily operation.

Tennessee

KINGSPORT.—The Clinchfield Portland Cement Corporation is making rapid progress in the construction of its new potash plant, which will be devoted to the manufacture of potash from the waste dust and gases generated in the production of Portland cement. The new plant is estimated to cost $200,000.

Texas

HOUSTON.—Fire recently destroyed a portion of the plant of the Tofte Boiler & Sheet Iron Works, with loss estimated at $40,000, of which $20,000 was in machinery. It is said that the plant will be rebuilt.

TEXAS CITY.—The Pierce-Fordyce Oil Association, manufacturer of oils, greases, paraffine wax, etc., is building several new storage tanks at its plant. The facilities of the works are being constantly added to, and its capacity is now practically double what it was two years ago. The company operates in three eight-hour shifts.

Utah

ALUNITE.—The Mineral Products Company is rushing to completion the construction of the first unit of the new fireproof plant to replace the works recently destroyed by fire with loss of about $250,000. The new plant is estimated to cost $1,000,000.

SALT LAKE CITY.—The Koering Cyaniding Process Company, Detroit, Mich., is planning for the removal of its offices and works, and will establish its laboratories locally. Dr. Maximilian Markus is secretary and treasurer of the company.

Vermont

WINDSOR. — The Cooley-Wright Company, operating a large foundry at Waterbury, is planning for the establishment of a new local foundry. A factory building has been acquired, and improvements and alterations will be made to meet the requirements of the company.

Virginia

CHARLOTTESVILLE. — The American Sulphides Corporation, recently incorporated with a capital of $400,000, is planning for the development of 600 acres of land, with a daily capacity of 150 tons. Alvin T. Embrey, Fredericksburg, is president of the company.

Canada

SAULT STE. MARIE, ONT.—The Wilputte Coke Oven Corporation, of New York City, has been awarded a contract for the installation of twenty-five Wilputte regenerative by-product coke ovens, with certain by-product equipment, as an extension to the present coke oven plant of the Algoma Steel Corporation, Ltd., at Sault Ste. Marie, Ontario, Canada. Work will be started immediately, and the construction is expected to be completed by July 1st, 1918.

Manufacturers' Notes

THE ASBESTOS PROTECTED METAL COMPANY of Pittsburgh, Pa., announces that on and after December 1st, 1917, it will be represented in the state of Georgia by J. F. Schofield's Sons Company located at Macon.

W. L. FLEISHER & CO., contracting industrial engineers of New York City, removed their offices on December 1 to 31 Union Square West.

THE ELECTRIC FURNACE CONSTRUCTION COMPANY of Philadelphia announce the sale of a "Greaves-Etchells" electric furnace to the Ford Motor works of Detroit, Mich. This furnace is in connection with special government aircraft work. They also announce the sale of two 3-ton furnaces to the Halcomb Steel Company of Syracuse, N. Y., which will also be used for special aeroplane and motor steels.

THE PFAUDLER CO., Rochester, N. Y., has established a branch sales office at 440 Pierce Building, St. Louis, Mo., in charge of Mr. George E. Gray, who has, for some time, been connected with the Chicago office. The agency for the company's products has been granted to C. M. Jackson Co., 512 Gould Building, Atlanta, Ga.

E. S. LINCOLN, INC., has removed from Waterville to 534 Congress Street, Portland, Me., where the laboratory will be maintained similar to that at Waterville.

Manufacturers' Catalogs

NORTON COMPANY, Worcester, Mass., has issued a complete little booklet on tool room grinding.

NUTTALL, Pittsburgh, has issued a new catalog on Nuttall industrial products, gears, pinions, etc.

BACHARACH INDUSTRIAL INSTRUMENT CO., Pittsburgh, Pa., has issued catalog D describing the "hydro" pressure recorder.

THE BORDEN COMPANY, Warren, Ohio, has issued its 1918 catalog of Beaver die stocks and square-end pipe cutters.

WORTHINGTON PUMP AND MACHINERY CORPORATION of New York City has issued catalog D-1301 on Deane automatic pumps and receivers.

CENTRAL SCIENTIFIC COMPANY, Chicago, has issued Bulletin No. 50 describing a new de Khotinsky single walled drying oven.

THE DENVER ENGINEERING WORKS COMPANY, Denver, Colo., has issued Bulletin No. 1078 describing the Richards improved pulsator jig.

THE J. P. DEVINE COMPANY, Buffalo, N. Y., has just issued Bulletin No. 104, covering its patented vacuum drying and impregnating apparatus, which gives detailed information of the equipment developed for use for impregnation of armature, field, magnet and transformer coils, power and telephone cables and insulator pins. The bulletin also describes special cable dryers and combined cable dryers and vulcanizers.

New Publications

WOMEN'S WORK IN WAR-TIME. Published by the Merchants National Bank of Boston, Mass., to assist manufacturers in this country in meeting the shortage of labor. This information has been obtained direct from the British Government and other authoritative sources. The operation of the leading industries in England wherein women have replaced men are outlined and have been changed to meet individual conditions in this country.

SILVER, COPPER, LEAD AND ZINC IN THE CENTRAL STATES IN 1916. Geological Survey Report by J. P. Dunlop and B. S. Butler.

GOLD, SILVER, COPPER AND LEAD IN ALASKA IN 1916. Geological Survey Report by A. H. Brooks.

THE TRAINING AND WORK OF THE CHEMICAL ENGINEER. Reprinted from Transactions of Faraday Society, 82 Victoria Street, London, Eng.

BLAST FURNACE BREAKOUTS, EXPLOSIONS AND SLIPS. Bureau of Mines Bulletin 130, by F. H. Willcox.

IRON ORE OCCURRENCES IN CANADA. Department of Mines Publication No. 217, by E. Lindeman and L. L. Belton. Two volumes.

BARYTES AND BARIUM PRODUCTS IN 1916. By James M. Hill, pages 243 to 254 of Mineral Resources of the United States, 1916—Part II, published Sept. 20.

SILICA IN 1916. By Frank J. Katz, pages 283 to 287 of Mineral Resources of the United States, 1916—Part II, published Sept. 24.

SECONDARY METALS IN 1916. By J. P. Dunlop, pages 39 to 52 of Mineral Resources of the United States, 1916—Part II, published Oct. 6.

LABORATORY DETERMINATION OF THE EXPLOSIBILITY OF COAL DUST AND AIR MIXTURES. By J. K. Clement and J. N. Lawrence. Technical Paper 141 of the Department of the Interior, Bureau of Mines.

EFFECTS OF HEAT ON CELLULOID AND SIMILAR MATERIALS. By H. N. Stokes and H. C. P. Weber. Technologic Paper of the Bureau of Standards No. 98, issued Oct. 15, 1917. Price 5 cents.

THE PRODUCTION OF IRON AND STEEL IN CANADA DURING THE CALENDAR YEAR 1916. By John McLeish. Bulletin No. 458, published by the Canadian Department of Mines.

Foreword

IN the following pages are presented brief descriptions of some of our activities, facilities and standard manufactures of special interest to the chemical and allied industries.

The equipment described includes chemical apparatus, vacuum dryers, and evaporators. In designing these, our chief aim has been to produce simplicity in construction, efficiency in operation and durability in service. In other words "Buflokast" and "Buflovak" apparatus is

"Built for Tomorrow's Satisfaction
Instead of Today's Price."

Our organization, engineering, manufacturing facilities, Research Laboratories, and our consulting specialists are at your service.

Buffalo
Foundry & Machine
Company

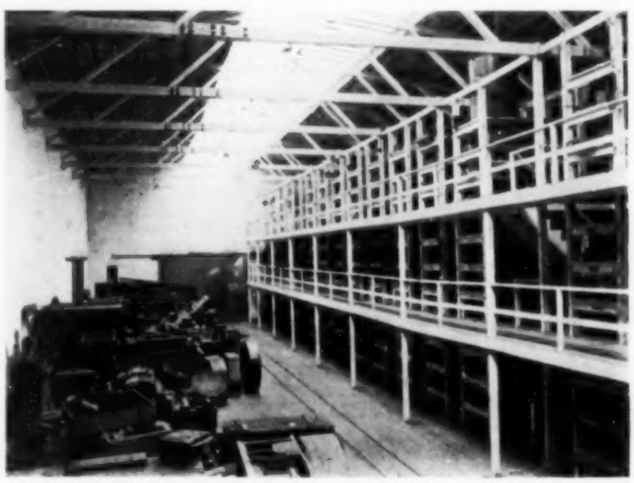
A Trip Through the Plant

The Foundry

One of the first points of interest in a foundry to attract a visitor is the melting equipment. Our foundry contains three cupolas and an air furnace. The cupolas are respectively 102, 84 and 66 inches in diameter and have a total melting capacity of 55 tons per hour.

Air Furnace

Used for producing "Buflokast" Acid-Resistant and other special metals in the manufacture of our various lines. In practice it is operated like a large crucible so that practically any quality of iron desired can be produced in this furnace with almost laboratory exactness.



Pattern Storage

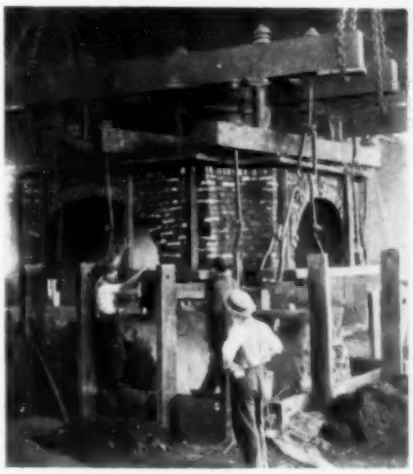
Special attention has been given to the storage of patterns. All patterns received from customers are carefully checked to drawing before going to the foundry. They are as well taken care of by us as they could be by the owner.

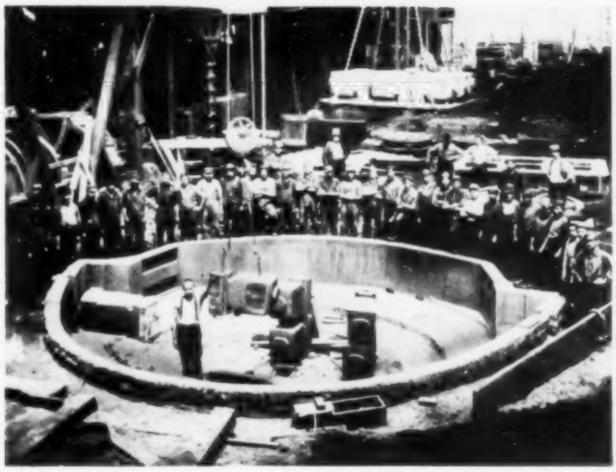
1543 FILLMORE AVENUE, BUFFALO, NEW YORK

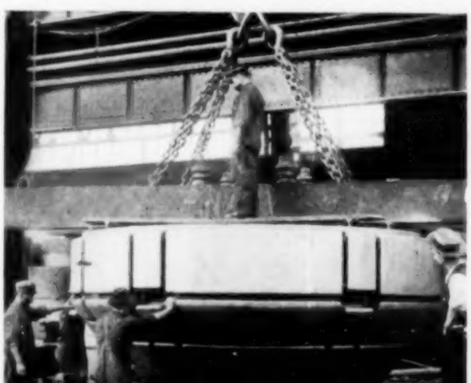
A Trip Through the Plant—*Continued*

Pattern Shop

Our pattern making department is modern and up-to-date, and is a model for producing patterns at a minimum cost. New patterns and alterations are made in a manner most suitable for economical and accurate molding.



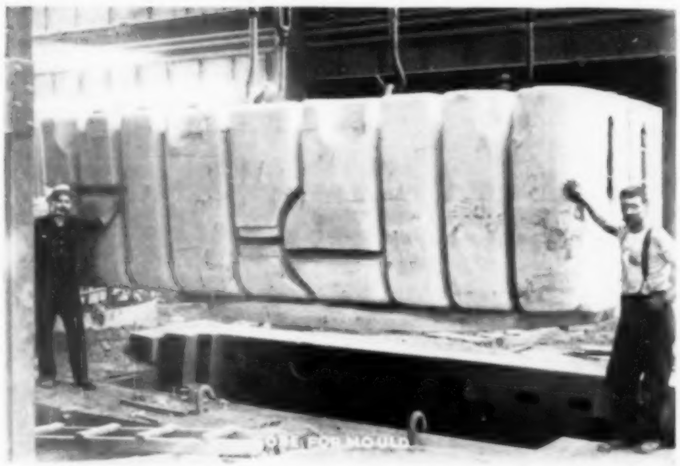




The illustrations give some idea of the size castings we can make. The casting on the right was produced in the mold shown directly above.

A Trip Through the Plant—*Continued*

Our facilities enable us to make castings weighing up to 200 tons each. Frequently the cores weigh almost as much as the casting itself, so that it is necessary to have exceptional crane capacity to lift the castings from the mold after being cast.



This shows the core being placed in the mold shown above. We are well equipped with core-drying facilities, having 32,000 cubic feet of core-oven capacity, and can dry a single mold or core up to 25 feet long, 25 feet wide and 14 feet high.

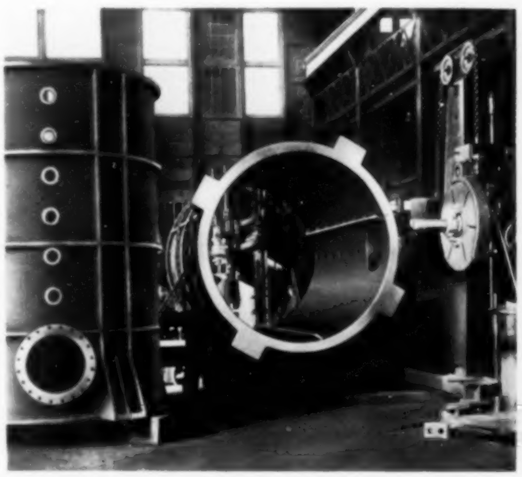
Plate Shelf Shop

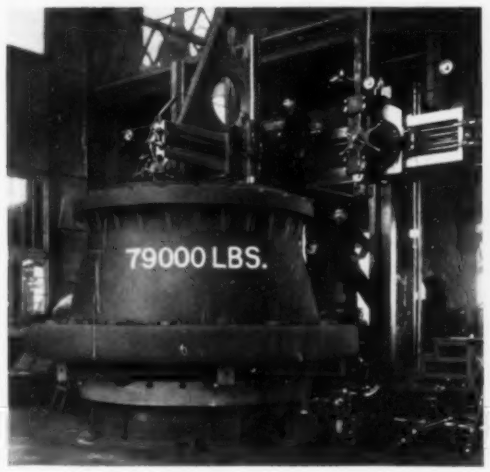
Used for constructing the shelves for our Vacuum Shelf Dryers. The various operations are drilling the rerolled steel plates; bending; welding, both electrically and by the oxy-acetylene process; hot riveting; re-riveting while shelf interior is under high pressure. Great care is taken in the fabrication of these shelves, which are so constructed as to insure the proper distribution of steam, in order that the shelves may be uniformly heated throughout.

A Trip Through the Plant—*Continued*

Machine Shops

These are equipped with the largest and most up-to-date appliances for turning out work accurately and with despatch. The cuts illustrate the size and flexibility of some of our equipment.





Another view of the main machine shop. An interesting feature about our plant is the fact that it is operated by power derived from Niagara Falls. The current is received at 2200 volts and reduced in our power house to 220 volts.

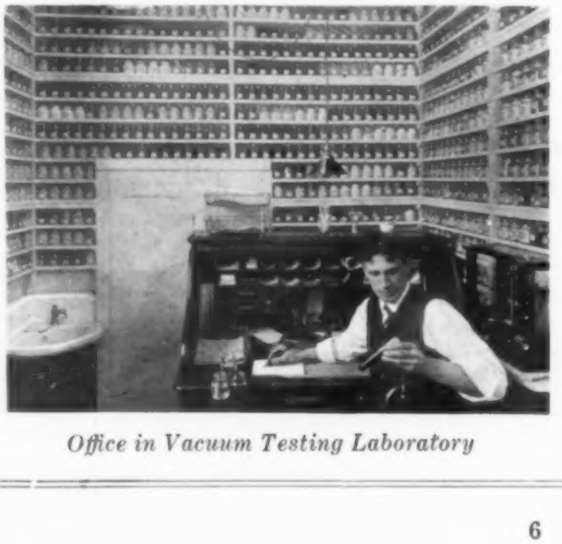
A Trip Through the Plant—*Continued*

Research Laboratories

In our new Research Laboratories Building (shown above) we have brought together the various laboratories connected with our plant. They are as follows:

Organic and Inorganic Chemical Laboratories. This department contains working units for conducting practical experiments in various operations of organic and inorganic chemistry for which we manufacture apparatus.

Organic Chemical Laboratory



Office in Vacuum Testing Laboratory

Demonstrating and Testing Laboratory, containing units of various types of vacuum dryers, evaporators, etc., for experiments in Vacuum Drying, Evaporating, and other vacuum processes.

Metallurgical Laboratory.

Physical Testing Laboratory.

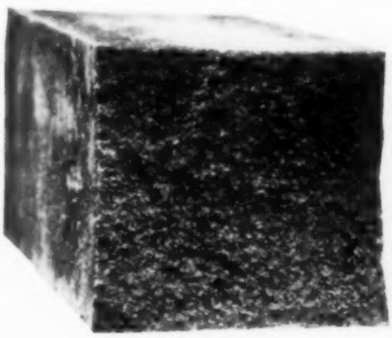
Qualified experts are in charge and customers are invited to make liberal use of these laboratories.

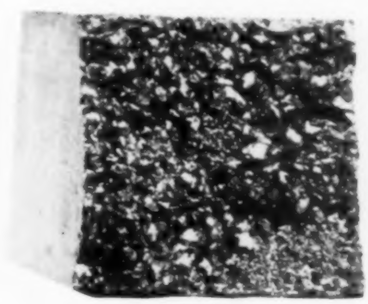
A Trip Through the Plant—*Continued*

Laboratory Control

Laboratory control, which was first applied successfully to the manufacture of castings on a chemical basis, is the dominating idea behind every product of this company. Completely equipped metallurgical, chemical and physical testing laboratories are maintained at our works, and all materials received such as pig iron, scrap, coke, etc., are chemically analyzed. All finished products are carefully checked both chemically and physically.

Metallurgical Laboratory

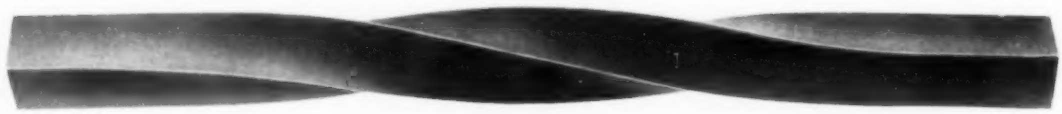




The illustrations show some of the results of laboratory-control as applied to the question of metal alone. On the one hand is shown a section of cast-iron of an extremely dense, homogeneous quality—on the other a porous, open-grained iron. The other illustrations (the springs) indicate a mixture of iron having unusual ductile qualities. A spring was cut from a solid piece of cast iron, making a spring 19 in. long in its normal position, as shown by the first illustration. The other cut shows it compressed to

A Trip Through the Plant—*Continued*

LABORATORY CONTROL—*continued*



2 in. The spring can be pulled out, without breaking, to more than double its length.

The bars shown in the illustrations demonstrate still another quality. These were cast square and straight, after which they were twisted as shown in the cuts, a test which has always been considered impossible on cast iron.

These widely differing qualities of metal, with many grades and variations of the same, are made possible by the system of exact control established over our various manufacturing processes.

Other factors are treated with the same care, no detail looking toward the efficiency and durability of "Buflokast" and "Buflovak" products being too small to receive the most careful attention.

The Full Significance of "Buflokast" and "Buflovak"

Besides being distinguishing marks by which certain products may be identified, these names have another and deeper significance. Either name when appearing upon or applied to the products of this company means that it is the best that can be built regardless of price. It becomes a stamp of quality—standing for certain fixed principles in manufacture and a definite standard of service.

They represent the application to each customer's particular problem, of predetermined facts, based on scientific research and manufacturing experience. In short "Buflokast" and "Buflovak" are names by which the most satisfactory and most economical chemical equipment and vacuum apparatus may be recognized. They stand for, not lowest initial cost, but the lowest ultimate cost—the only true standard of economy. Quality and not price is the basis on which these products are built and sold.

1543 FILLMORE AVENUE, BUFFALO, NEW YORK

Engineering
and
Consultation

THE success of "Buflokast" and "Buflovak" equipment rests largely on the ability possessed by our engineering department to deal effectively with chemical problems.

In addition to the services of our regular engineering staff, we place at your disposal consultation with specialists occupying the foremost position in their respective fields. Besides enlarging the scope of our engineering, we thus secure an *outside view-point* on your problem.

Among the fields covered are:

Organic Chemicals
Heavy Chemicals, Acids and High Explosives
Evaporators and Caustic Alkalies

The professional advice of these men is backed by our exceptional facilities and the scientific control over the manufacturing processes in our laboratory-controlled plant.

We are also adding to our engineering and consulting staff as fast as new fields develop where our research and experience can be applied.

Experimental Work

Our Research Laboratories contain departments for conducting practical experiments in vacuum drying, evaporating, and in many of the chemical and mechanical operations of organic and inorganic chemistry. These experiments are conducted without charge or obligation, except for furnishing materials and paying transportation charges.

Complete Plants

THE striking development of the chemical industry in America has brought forcibly to the front the service rendered by this company in making it possible for American manufacturers to meet the many new problems, as a result of the war, that confronted them.

An important feature of this work was the ability to furnish Chemical Apparatus and

Complete Chemical Plants

these plants being designed, constructed and operated (under guarantee where desired).

In the following pages are mentioned many materials whose satisfactory production can be assured by using the "Buflokast" Equipment designed for the particular product to be manufactured.

Individual Pieces Also Furnished

Where an entire chemical plant is not desired, we can supply any section of the same, or individual pieces of apparatus, for many chemical operations, such as nitration, sulphonation, reduction, chlorination, caustic fusion, etc.

Recovery of Waste Products

CONSIDERING the exceptional growth of the chemical and allied industries, it is more than ever necessary to give careful attention to the recovery of by-products and utilization of waste materials. Recovery plants are of national importance, not only from the economical but also from the sanitary point of view. Every day new problems arise and close co-operation between owner and manufacturer is necessary to get the best results. We gladly place the facilities of our Research Laboratories at the disposal of our customers.

Some of the most important products to be recovered and waste materials to be utilized are:

Acids, Caustic Soda and Sulphite in the Coal-Tar and Explosive Industries,

Caustic Soda and Sulphite Waste in Pulp Mills,

Caustic Soda in Mercerizing Plants,

Fats and Potash in Woolen Mills,

Fertilizers from Packing Houses and Fish Industry,

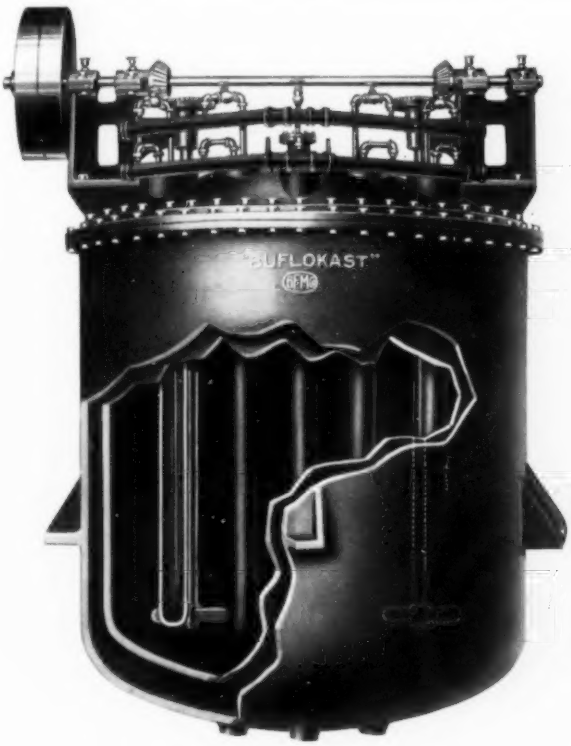
Cattle Feed from Breweries and Distilleries,

Potash from Sugar Waste,

Caustic Soda in Rubber Manufacturing Plants,

Tanning Liquors in the Tanneries.

1543 FILLMORE AVENUE, BUFFALO, NEW YORK



"Buflokast" Nitrator

The "Buflokast" Nitrator is noted for its high yield. It consists of a special cast-iron body surrounded on the sides and bottom with a cooling jacket. Thorough agitation is caused by means of two propellers placed on vertical shafts and located at opposite sides of the kettle. The use of two propellers is a new feature of the "Buflokast" Nitrator and assures constant agitation even though one propeller should become inactive for any cause.

Another special feature is the arrangement by which the acid is charged below the level of the liquid or near the bottom where the most agitation takes place.

It also contains a series of closed end tubes, which provide exceptionally quick cooling facilities in the center as well as along the sides of the interior. Water is forced to the bottom of the tubes, which are individually controlled. The temperature of the overflow from each tube can be noted and is regulated by a valve. The use of these tubes is made possible by our patented method of casting the tubes without chaplets, thus insuring freedom from leaks. This is the only successful method so far devised for manufacturing these tubes.

Other features are ball bearings; special semi-steel out gears; large factor of safety, etc.

The apparatus is constructed throughout to withstand the heavy duty it is designed to perform. The special quality of metal used in the nitrator body, cast iron shaft and closed end tubes is the result of our long experience in furnishing castings for chemical work.

"Buflokast" Nitrators are furnished in four standard sizes with capacities as follows: 1,600 gallons; 800 gallons; 400 gallons; 200 gallons. Special sizes, or nitrators for operations requiring other special features, are built to order.

Used in Manufacturing

Nitrobenzol
Nitrotoluol
Aniline
Toluidine
Xylidine
Dinitrobenzol
Dinitrotoluol
Meta-Nitraniline
Meta-Phenylenediamine
Meta-Toluylenediamine
Nitrochlorbenzol
Dinitrochlorbenzol
Para-Amidophenol
Dinitrophenol
Para-Nitraniline
Para-Phenylenediamine
Alpha-Naphthylamine
Alpha-Naphthylamine-Sulfonic Acids
Amido-Naphthol-Sulfonic Acids
H-Acid
Etc., etc.

BUFFALO FOUNDRY AND MACHINE COMPANY

"Buflokast" Reducer

Especially noted for its large output, ease and cleanliness of operation. Carefully constructed to meet the working conditions for which it is designed. The apparatus consists of a specially constructed cast iron body. The bottom and lower portion of sides are lined with special quality liner plates which are readily removable and can be renewed as occasion requires. The side plates are reversible, so that the upper portion of the plate can be used when the bottom part has become worn.

The shaft and agitator are suspended from a bearing in the top of the reducer and is also supported by a heavy bearing in the yoke midway in the reducer, as illustrated, thus eliminating the objectionable bottom or step bearing commonly used. A special feature of both shaft and agitator is that they are hollow, the steam being introduced through the shaft at the top and distributed in the reducer by means of outlets in the agitator. The agitator is of the tooth type, which insures better agitation and requires less power to operate than the plow type, so commonly used.

A large door on the side facilitates the removal and renewal of the liner plates when required, this door being fully protected by the lining. The materials and workmanship are first-class throughout, the cast iron being of a special quality as used in apparatus of this character.

Other features are the improved unloading device which automatically raises the valve when opened, and wedges it in position when closed; semi-steel cut gears, large factor of safety, etc.

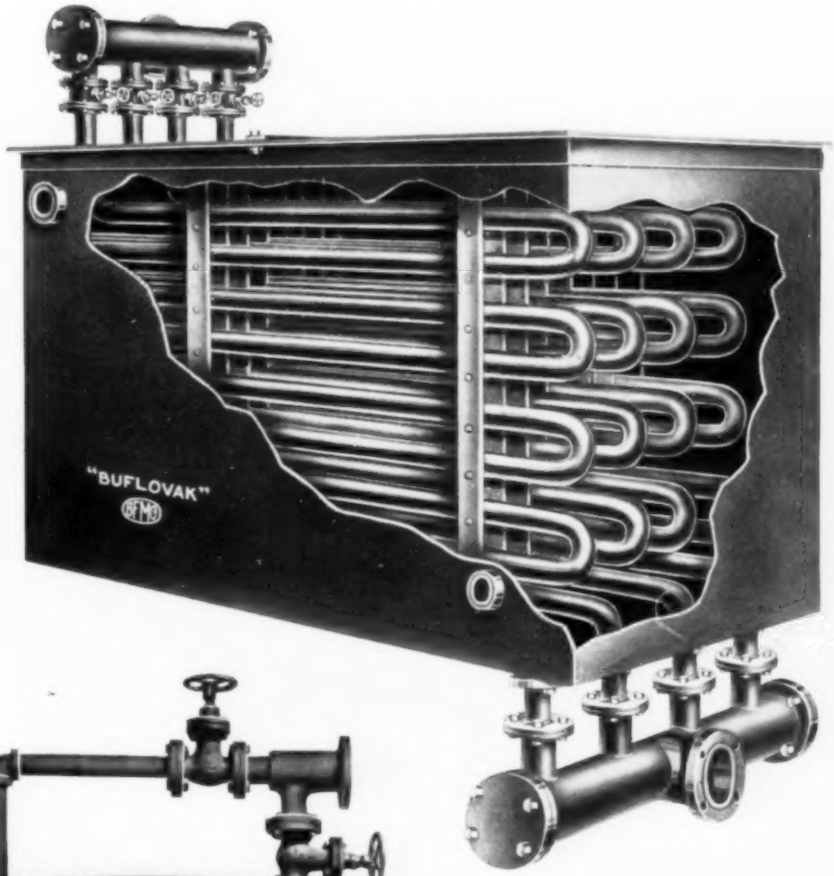
Where a reducer with higher heating facilities is desired, we furnish the jacketed type, which is illustrated above.

"Buflokast" Reducers are built in four standard sizes with capacities as follows: 1600 gallons, 800 gallons, 400 gallons, 200 gallons. Special sizes, or reducers for operations requiring other special features can be built to order.

Used in Manufacturing

Aniline
Toluidine
Xylidine
Benzidine
Tolidine
Meta-Nitraniline
Meta-Phenylenediamine
Meta-Toluylenediamine
Metanilic Acid
Para-Amidophenol
Para-Phenylenediamine
Alpha-Naphthylamine
Alpha-Naphthylamine-Sulfonic Acids
Amido-Naphthol-Sulfonic Acids
H-Acid
Etc., etc.

1543 FILLMORE AVENUE, BUFFALO, NEW YORK

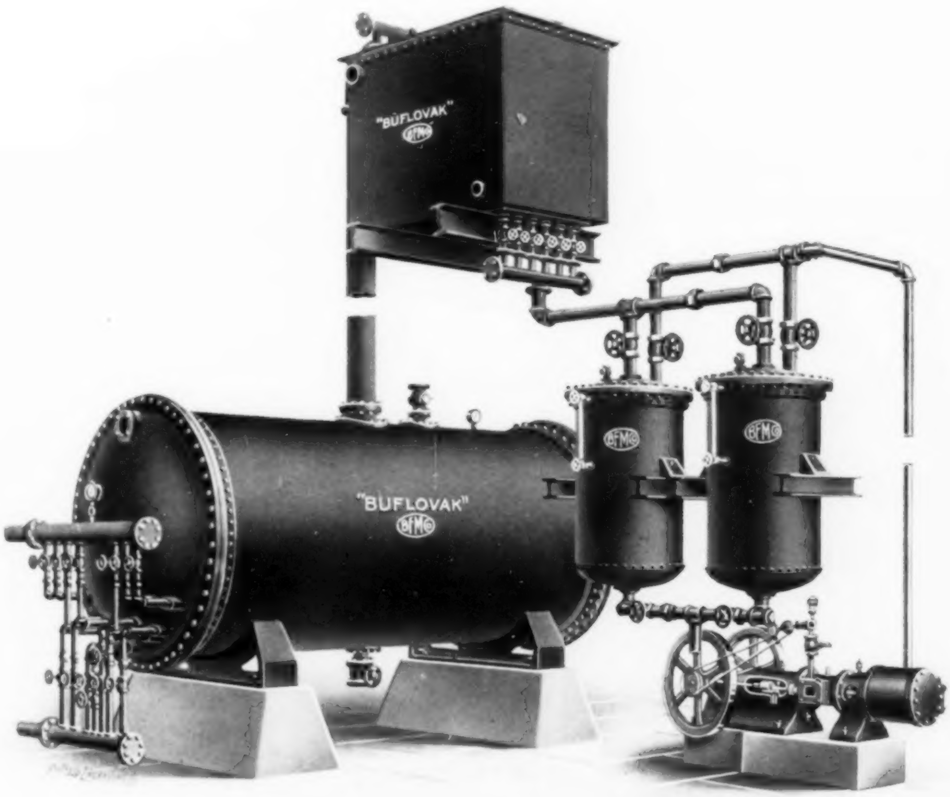


"Buflovak" Reflux Condensers

"Buflovak" reflux condensers are built in two types. One is rectangular in form with four zig-zag coils of wrought iron pipe. All coils are connected by manifold, with this great advantage—that each coil can be regulated independently of every other.

The other type condenser is circular in form, and being of more simple construction is less expensive than the rectangular type. It is in extensive use and gives efficient service.

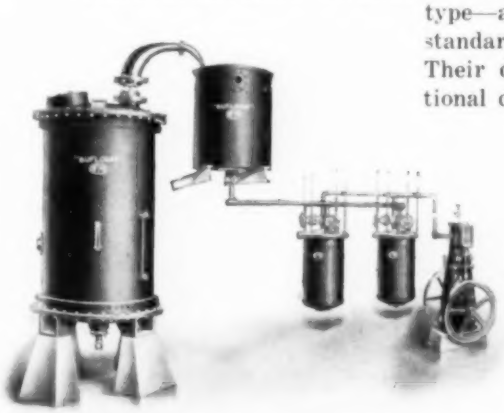
1543 FILLMORE AVENUE, BUFFALO, NEW YORK



"Buflovak" Vacuum Still

Constructed of heavy steel plate and provided with heating coils in the bottom of the still. A goose-neck and vapor pipe extends from the top to a condenser of ample capacity. The still is also provided with two receivers and a vacuum pump.

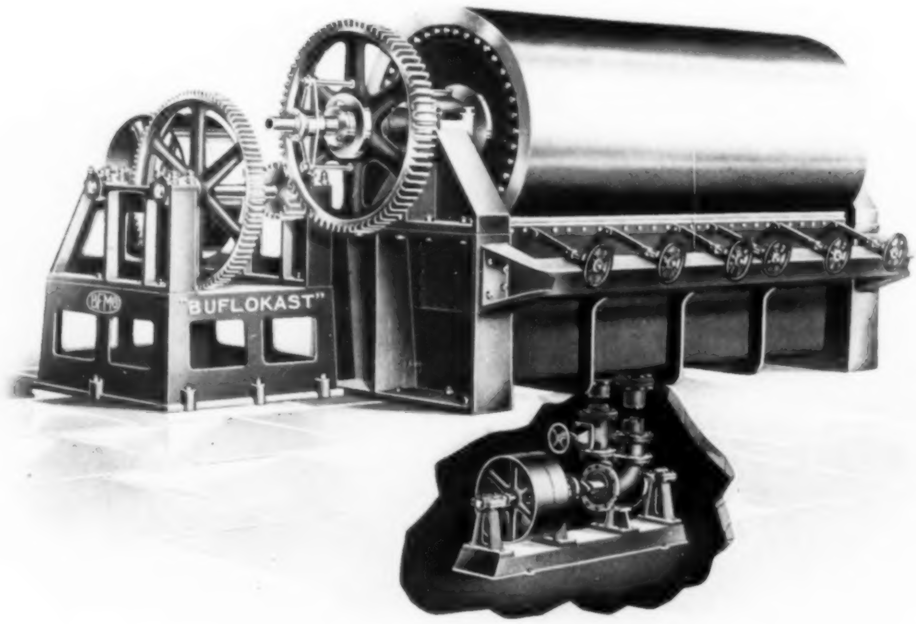
These vacuum stills—furnished in various sizes, either the horizontal or vertical type—are built in accordance with the high standards of our other Vacuum Apparatus. Their design has been worked out with exceptional care as to details.



Used in Manufacturing

Aniline
Toluidine
Xylidine
Ortho-toluidine
Para-toluidine
Benzaldehyde
Etc., etc.

BUFFALO FOUNDRY AND MACHINE COMPANY



"Buflokast" Atmospheric Drum Dryer

Our laboratories have worked out new methods and apparatus for manufacturing various materials—the "Buflokast" Atmospheric Drum Dryer being but one example of the equipment thus produced.

The patented, successful principles of operation in this dryer are the cause of its exceptional success. It embodies the principles of the famous "Buflovak" Vacuum Drum Dryer. It is used for drying many liquid materials which do not require a vacuum, such as sodium benzol sulphonate, sodium acetate, sodium naphthalene sulphonate, etc.

This dryer consists of a hollow cylindrical drum supported over a cast iron storage tank. This drum is made of a special quality of cast iron, and has a smooth polished surface. The steam is introduced through the bearing at one end and the condensed steam or water is drained off through the opposite end.

The storage or reserve tank is made in one piece, thus eliminating joints in the tank and removing all danger of leakage through parts becoming loose or disconnected.

Our patented automatic device for applying the liquid to the drum produces a uniform coating on the drum and consequently a uniform dry product. The arrangement is such that only a small part of the drum surface is in contact with the wet material, leaving a greater working area for the drying of the material and thus producing a maximum output at a minimum cost for steam, power and labor. The scraper or knife is adjusted to the drum by a special device—controlled by a series of handwheels—which permit the most accurate and delicate adjustment.

These dryers are furnished in four standard sizes, the cut showing largest standard size, having a drum 5 ft. diameter by 12 ft. long. Special sizes built to order as required.

1543 FILLMORE AVENUE, BUFFALO, NEW YORK

"Buflokast" Autoclaves

Space does not permit much detail. The illustrations speak for themselves. "Buflokast" Autoclaves are built for any pressure as desired. They are constructed of cast steel, bronze or cast iron, depending on the pressure desired and the nature of the material to be treated. Built with or without outer jacket and with or without stirring devices.

Where the action of the material being treated makes it desirable a special lining of "Buflokast" acid-resistant or other special metal is provided, as shown in the 75-gallon autoclave, used in manufacturing Dimethylaniline and other similar products.

The design and construction of "Buflokast" Autoclaves are typical of those which characterize all "Buflokast" Apparatus.

Built in all commercial sizes.

We also manufacture many small sizes for laboratory purposes. Autoclaves of special size and design built to order.

Used in Manufacturing

Dimethylaniline
Para Amidophenol
Anisidine
Phenetidine
Phenacetine
Alpha-Naphthol
Amido-Naphthol-Sulfonic Acids
H-Acid
Gamma Acid
Beta-Naphthylamine and its sulfonic acids
Etc., etc.

BUFFALO FOUNDRY AND MACHINE COMPANY

"Buflokast" Caustic Pots

These pots are so widely known throughout the chemical industry that a brief reference to them will suffice here. With very few exceptions all the caustic pots now used are "Buflokast." The success of these pots is clearly indicated by reports from our customers showing that they give from three to five times more service than those purchased elsewhere, either in this country or abroad. "Buflokast" Pots are built in varying sizes up to the capacity of the railroad companies to handle them, most manufacturers preferring to use the largest size they can secure.

Caustic Flaking Apparatus

It is becoming evident that the demand for flaked caustic soda will continue to grow. We are prepared to furnish apparatus for this purpose, having made a number of successful installations. Full information on request.

A Single Shipment of Caustic Pots

1543 FILLMORE AVENUE, BUFFALO, NEW YORK

"Buflokast" Fusion Kettles

The important feature about "Buflokast" Fusion Kettles is the fact that they are made of the same quality of metal used successfully for so many years in the manufacture of our caustic pots. This mixture of metal is designed to combat or resist the combined action of the caustic and the temperature to which the kettles are usually subjected.

The kettle is provided with an improved type agitator and shaft made of the same metal as the kettle. The agitator and shaft are cast together in one piece, which construction gives a longer life than when cast separately and bolted together. The agitator is suspended from a heavy bridge at the top which also supports the driving mechanism. The shaft operates in a removable seat, which can be renewed when worn, as occasion requires.

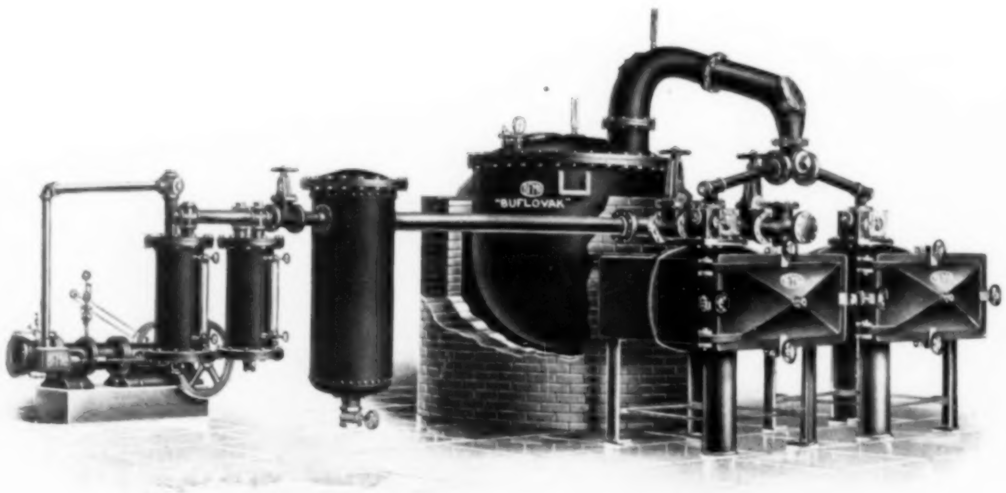
The "Buflokast" Fusion Kettle can be furnished with a draw-off spout at the bottom when this is desired.

The kettles are built in various sizes as required, the most popular being our 600-gallon and 1500-gallon sizes.

Used in Manufacturing

Carbolic Acid
Beta-Naphthol
Resorcine
Nigrosine
Etc., etc.

BUFFALO FOUNDRY AND MACHINE COMPANY



"Buflovak" Beta Naphthol Still

The illustration shows the general arrangement of a "Buflovak" Beta Naphthol Still with condenser, receivers, separators, vacuum pumps, etc. Judging by reports from users, it is doubtless the most successful still for the purpose now in use. It overcomes the difficulties encountered in Beta Naphthol distillation, especially in subliming, and vapors are prevented from passing to the vacuum pump. Built in various sizes as required.

Used in Manufacturing

Para-Phenylenediamine
Diphenylamine
Alpha-Naphthylamine
Beta-Naphthylamine
Alpha-Naphthol
Beta-Naphthol
Etc., etc.

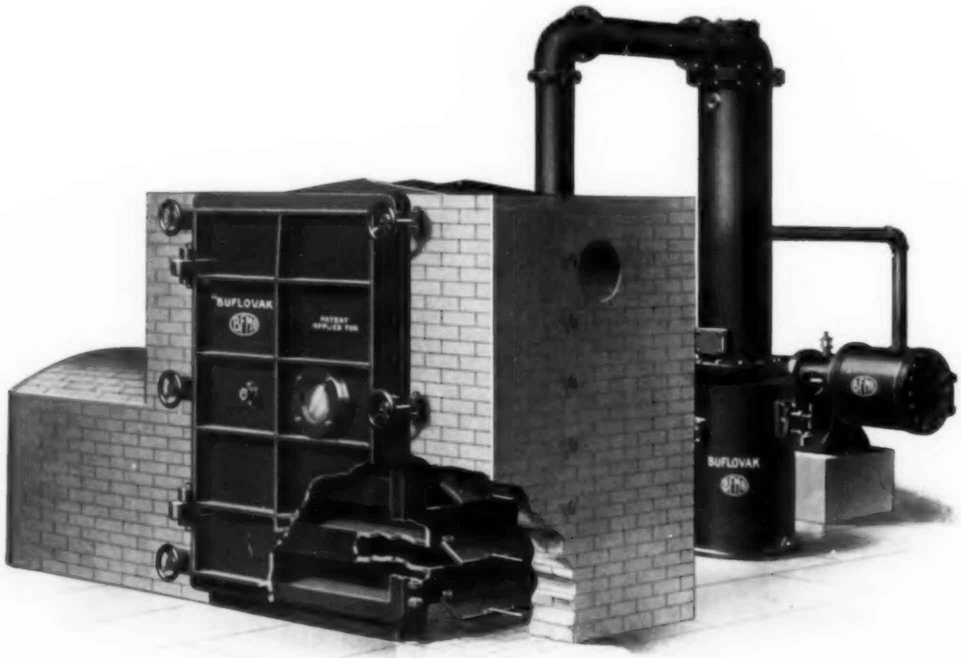
"Buflokast" Phenol (Carbolic Acid) Still

An efficient apparatus working successfully in many installations. Noted for its simplicity in design and durability in service. Constructed of a mixture of metal with special reference to the action of the acids combined with the temperature of the still while in service.

The top of the still is provided with a large manhole with cover, and an extended pocket for holding the charcoal basket, the latter being a special provision for deodorizing the vapors passing from the still to the condenser.

The condenser is arranged for water supply at the bottom and overflow at the top and is fitted with a special coil to prevent discoloration of the acid. The still is provided with lugs on the side for supporting the same on brickwork or furnace top. Built in varying sizes as desired, the illustration showing our 500-gallon size.

BUFFALO FOUNDRY AND MACHINE COMPANY



"Buflovak"
Direct Heat Shelf Retort

Used in the manufacture of Sulfanilic and Naphthionic Acids, and for reclaiming high boiling point solvents where solid materials must be heated and temperature control is of great importance. It is provided with ducts passing from one side to the opposite side. Shelves are formed between the ducts. A full length door is provided on one side of the retort. The retort can be operated under vacuum and is connected with a dry vacuum pump and condenser as illustrated.

The material is placed on the shelves in pans and the hot gases from the furnace, in which the retort is placed, pass through the inside of the shelves. Waste heat from a boiler furnace can also be utilized.

The regulation of the temperature of each shelf is made by dampers which permit more or less of the hot air to pass through the shelf.

This retort is far more efficient and has a much larger capacity than the types previously used for this purpose and is much more rapid in its operation.

"Buflokast" Equipment for Heavy Chemicals Acid and High Explosives

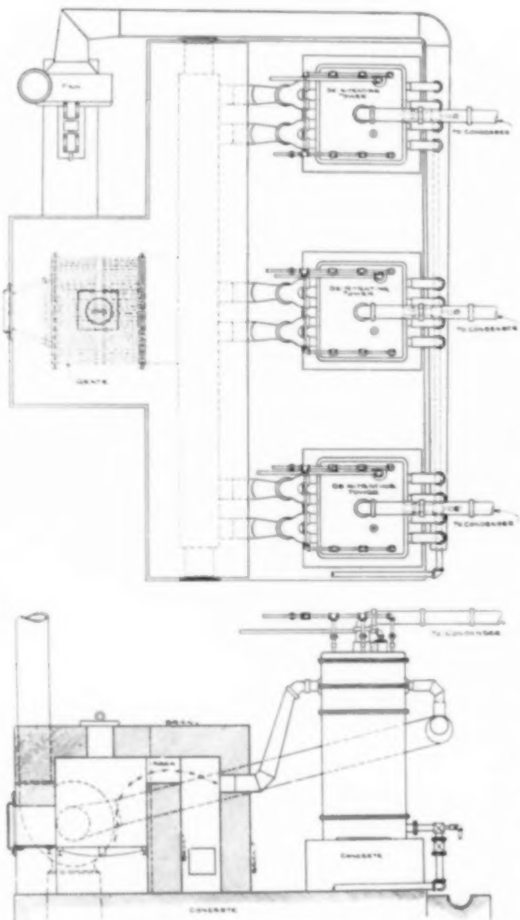
PERHAPS one of the most significant things that can be said about "Buflokast" equipment in this particular field is that "Buflokast" plants are used by a majority of the largest manufacturers of high explosives in the United States today.

We furnish complete plants or individual pieces of apparatus for the manufacture of Nitric, Sulphuric and Hydrochloric Acids; Trinitrotoluol and other products in the same field.

The experience of the past three years with "Buflokast" equipment for these products has shown the satisfaction that accrues to a manufacturer whose apparatus is based on *past experience* in industrial chemistry.

The following pages list a small part of our present activities in these fields.

BUFFALO FOUNDRY AND MACHINE COMPANY



"Buflokast" Denitrator

Used for the recovery of nitric acid from *waste acids* containing as low as 2 per cent nitric acid and up to 30 per cent. water, particularly from the waste acids obtained in the manufacture of Gun Cotton, TNT, Dinitrobenzol, etc.

This apparatus eliminates the use of steam for separating the acids, consequently no water is added to be again evaporated. The nitric and sulphuric acids are therefore recovered in more concentrated form than in the older processes. As an additional feature the nitrous compounds are also recovered in the form of nitric acid. The capacity of the "Buflokast" Denitrator is much higher than of the old type stills while the cost of operation and maintenance is exceedingly low.

Other advantages over the older processes are as follows: It occupies only one-sixth of the space formerly required; has a much longer life; vapor cannot become superheated or decomposed, which accounts for the great purity of acid obtained; larger heating surface in contact with the acid mixture; oxidizes a larger percentage of lower oxides of nitrogen; and eliminates the sediment usually found at the bottom of ordinary stills. *No objectionable fumes.*

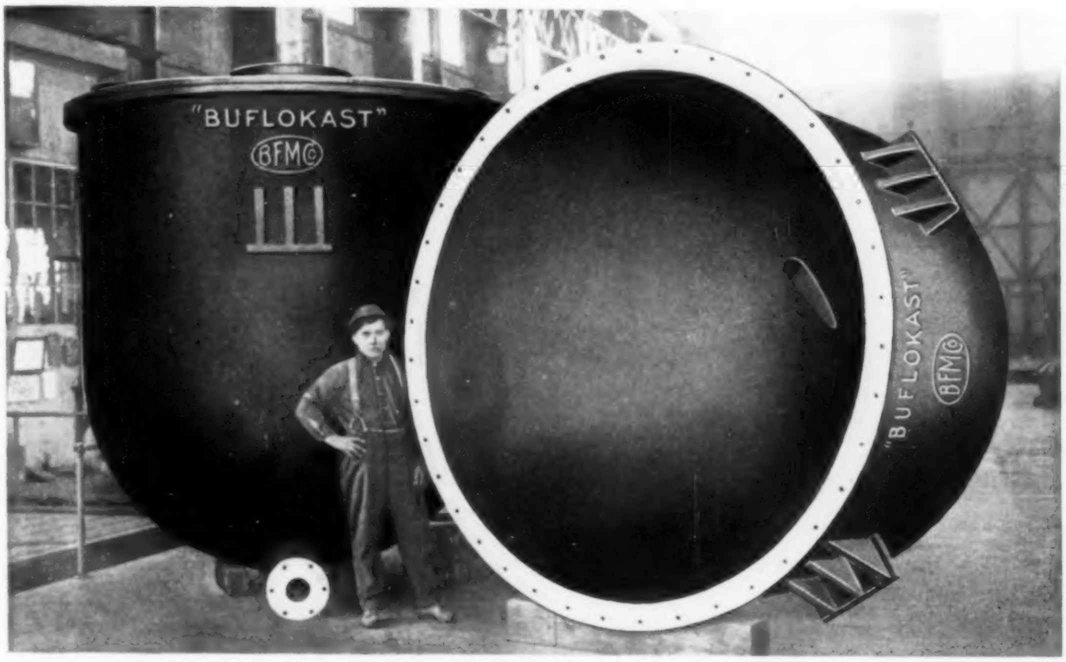
The results obtained with this denitrator may be judged from the facts that the nitric acid is recovered as 90 to 94 per cent acid, the nitrous compounds as 50 per cent nitric acid, and the sulphuric acid with a strength of 73 to 78 per cent.

The sulphuric acid may be further concentrated in a "Buflokast" concentrating pan made of acid-resisting metal, from which it can be recovered in any desired strength up to 98 per cent.

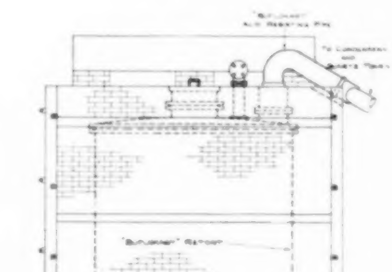
Cascade Recovery Systems

We also furnish, where desired, the cascade system equipped with "Buflokast" acid-resistant covered pans, absorption towers, coolers, etc.

1543 FILLMORE AVENUE, BUFFALO, NEW YORK



"Buflokast" Nitric Acid Plants



BUFLOKAST NITRIC ACID PLANT
BUFFALO FOUNDRY AND MACHINE CO
BUFFALO N.Y.

The etching shows the latest practice in nitric acid manufacture and speaks for itself. This is noted for its efficiency and economy and is conceded to be by far the most satisfactory method of manufacturing nitric acid.

The special type retorts here indicated and illustrated above are being used by most of the high explosive companies and other manufacturers of nitric acid. These retorts are furnished independently of the complete plant when so desired.

The manufacture of these retorts is an example of what can be accomplished by exceptional facilities, correct foundry and metallurgical methods. Furnished in the vertical and horizontal types in various sizes, as required.

BUFFALO FOUNDRY AND MACHINE COMPANY

"Buflokast" Crystallizing Pan

Used extensively in the manufacture of T N T and for concentrating and crystallizing various products under atmospheric conditions.

A special and exclusive feature of the "Buflokast" Crystallizer is the fact that the jacket is cast integral with the pan, as will be seen from the illustration. This eliminates all joints as well as the use of bolts, packing, etc. The advantage of this construction is obvious and requires only to be mentioned to be appreciated.

The "Buflokast" Crystallizer is used extensively in this country for evaporating the neutralized liquor of ammonia and nitric acid and drying and crystallizing the finished product. After the ammonium nitrate comes from this apparatus it is thoroughly dry. Steam is used in the jacket for concentration and cold water for crystallization.

Also used as an atmospheric dryer.

1543 FILLMORE AVENUE, BUFFALO, NEW YORK

"Buflovak" Vacuum Crystallizer

This apparatus embodies the same principles as the non-vacuum crystallizer, shown on the preceding page, except that it is operated under a high vacuum, thus causing more rapid crystallization and also permitting the handling of more delicate materials on account of the lower temperature employed. Excellent for "sticky" materials that become "gummy" or "ball up."

BUFFALO FOUNDRY AND MACHINE COMPANY

"Buflokast" Acid Eggs

Made in many sizes and types, horizontal and vertical, for various pressures, and to suit the special requirements of each case. "Buflokast" Acid Eggs are particularly noted for their durability, made as they are with a view to the service for which they are intended.

Special Chemical Castings

Jacketed Sulphur Kettle

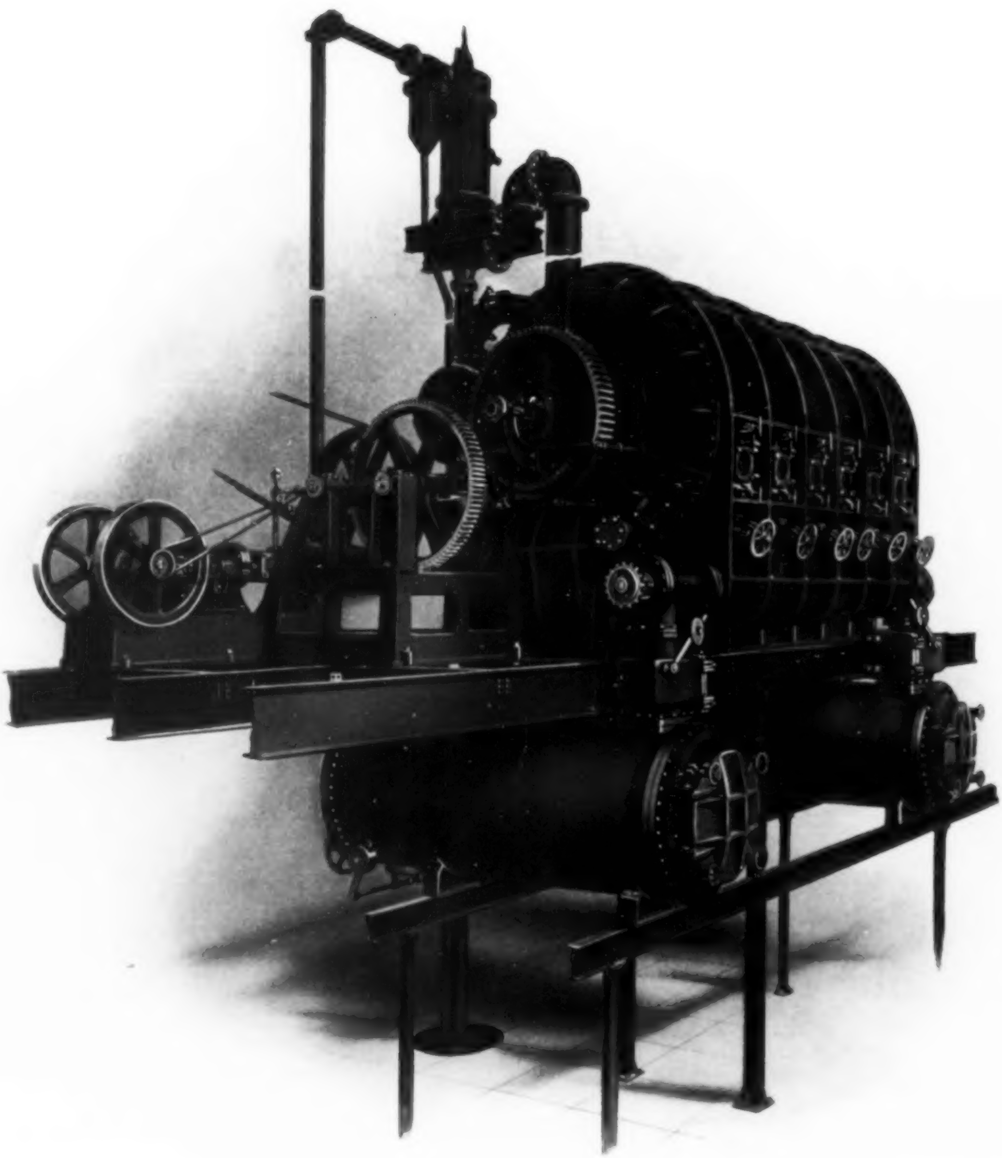
Besides the standard and special equipment mentioned in these pages, we are prepared to furnish castings for chemical, heat-resisting and other special purposes, having qualities not found in ordinary castings.

In making "Buflokast" Chemical Castings all materials used are first chemically analyzed and all metal mixtures produced with laboratory exactness. The result is a finished casting of known quality with physical and chemical properties suited to the conditions it is to meet.

Our facilities enable us to furnish special castings in any size that can be transported by rail.

Hydrochloric Concentrating Pan

BUFFALO FOUNDRY AND MACHINE COMPANY



"Buflovak"
Vacuum Drum Dryer

Equipped with two receivers (for continuous operation), vacuum pump, condenser, etc. This arrangement is used where the dry material can be mechanically conveyed.

1543 FILLMORE AVENUE, BUFFALO, NEW YORK

"Buflovak" Vacuum Drum Dryer

The ideal apparatus for converting liquids into a dry powdered or flake form. It is used for drying solutions, emulsions, and pulps, such as Dyewood Extract, Quebracho, White Lead, Glues, Milk, Acids, Chemicals, and other liquids containing solids.

This dryer consists of a hollow drum revolving in a sealed casing provided with devices for applying to and removing from the drum the material being treated, and for delivering the dry product to suitable receivers. The bottom of the chamber acts as a reservoir for the liquid. Agitators for mixing and coils for regulating the temperature of the material are provided when necessary. Steam or hot water is supplied to the interior of the drum. A high vacuum is maintained in the casing by means of a dry vacuum pump and the material is therefore dried at a low temperature. Moisture is removed by evaporation. A condenser is provided for condensing the vapors from the casing, and recovering them if desired.

The bottom portion of the dryer serves as a reservoir for holding a large quantity of the liquid material. Ample space is provided between the top surface of the liquid and the bottom of the drum to prevent foaming material reaching the drum. Agitators are provided for material requiring constant stirring. Coils are placed in the reservoir for heating or cooling the liquid when temperature regulation is desirable. The drum journals are supported in bronze bearings, and are equipped with suitable stuffing boxes, steam and drain connections. Observation glasses are provided for noting the interior operation of the dryer. Ample space between the drum and the casing is afforded in the larger dryers to permit all interior parts being thoroughly cleaned with a scrubbing brush and cleansing material.

For products which are removed from the drum in powdered or granular form, two receivers are usually provided to enable the dryer to be operated continuously, a conveyor being employed to deliver materials to one receiver, while the other receiver is being emptied. For flaky materials which cannot be readily conveyed a single large receiver is used, and the drying operation suspended while the dry product is being unloaded and the vacuum again created in the emptied receiver.

While the vacuum drum dryer has, in theory, been considered the ideal apparatus for drying liquids, satisfactory commercial results were not attained until our patented devices and methods for applying the liquid to the drum were perfected. Where the drum dips into the main body of the liquid, constant level cannot be maintained on many materials, due to the agitation and foaming of the liquid. This constant change in level makes a corresponding change in the amount of drum surface dipping in the liquid, which varies the moisture content in the finished product, interrupts the continuous operation of the dryer, reduces the output, and increases the cost of operation.

Our patented automatic device for applying the liquid entirely overcomes this condition, produces a uniform coating on the drum, and a uniform dry product. A maximum output is obtained at a minimum cost for steam, power and labor. As the drum in drying does not come in contact with the main body of liquid, all liquid materials containing solids can be dried satisfactorily, regardless of whether they foam or not in a vacuum.

The "Buflovak" Drum Dryer enables the most delicate liquid materials to be converted into dry form at extremely low tem-

Vacuum Drum Dryer—*Continued*

peratures—thus removing all danger from overheating—and at a very low cost of operation. In most cases the dried material is delivered as a powder, thus eliminating grinders.

All sizes are so constructed that they may be easily cleaned and kept in sanitary condition, which is a vital consideration when handling food products. The smallest dryer is so constructed that the casing over the drum can be readily moved back on a track so that free access can be had to all parts of the interior. The larger types are so arranged in size and convenience that a man can enter the casing and scour all parts of the interior.

Other Special Features

In all "Buflovak" Drum Dryers the main body or chamber casting is made in one piece. This elimination of joints in the main casting provides greater freedom from leaks, and a more rigid construction. The cast iron drum used in the apparatus is made of a special air-furnace metal, of a mixture determined by chemical analysis. We also make the drums of bronze or other alloys when required for materials which attack, or are injured, by cast iron.

The method of applying the liquid to the drum is such that only a small part of the drum surface is in contact with the wet material, therefore we have a greater working area of the periphery of the drum, have less steam consumption, greater drying speed, larger output, and lower drying cost.

As the drum does not dip into the liquid, the necessity of using end scrapers, collars, or banking devices is eliminated. In our apparatus the material cannot come in contact with the ends of the drum.

The knife holder has a large bearing the entire length of the dryer. The knife is adjusted to the drum by a special device—controlled by a series of handwheels—which permits the most accurate and delicate adjustment to the drum.

A large, liquid-sealed dust catcher is provided, making it impossible to lose any dry material which may arise in dust form. This dust catcher is so arranged that the material can be drained into dryer without breaking the vacuum on the apparatus.

Atmospheric Drum Dryer

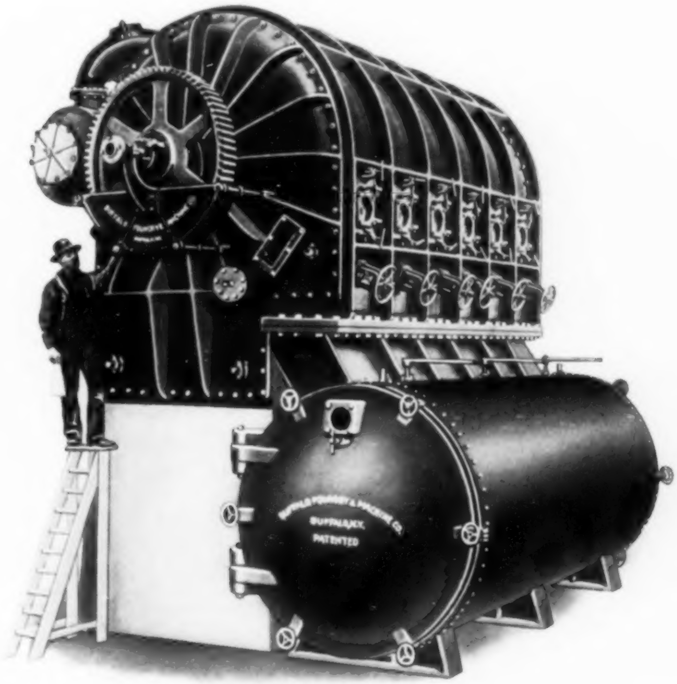
Attention is also called to the fact that the same principles used in the construction of the Vacuum Drum Dryer are also used in the construction of our Atmospheric Drum Dryers, which are used for drying many liquid materials that do not require a vacuum, such as Sodium Benzol Sulphonate, Sodium Acetate, etc.

STANDARD SIZES OF VACUUM DRUM DRYERS

No.	Diameter of Drum	Length of Drum	Weight	APPROXIMATE OUTSIDE DIMENSIONS		
				Length	Width	Height
1	24"	20"	16000 pounds	10′	8′	8′
2	48"	20"	32000 "	18′	10′	12′
3	48"	40"	44000 "	18′	12′	12′
4	60"	72"	70000 "	20′	24′	18′
5	60"	144"	100000 "	20′	30′	18′

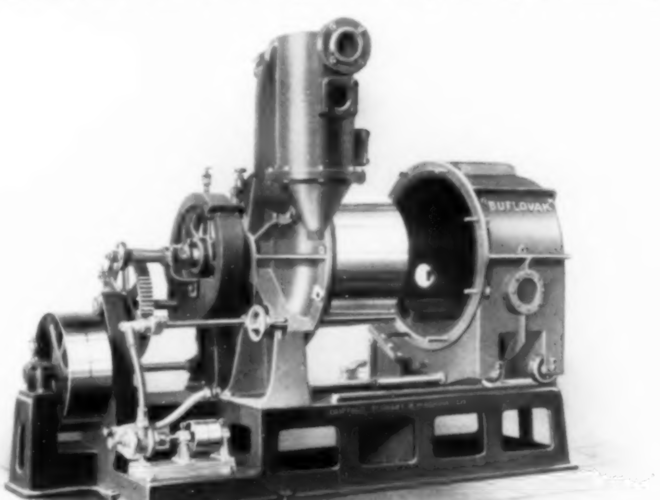
Weights include complete apparatus and are approximate. Vacuum Pump and Condenser not included in above space. Apparatus is usually equipped with barometric condenser. Will furnish surface condenser if desired.

SPECIAL SIZES BUILT FOR SPECIAL CONDITIONS



"Buflovak" Vacuum Drum Dryer

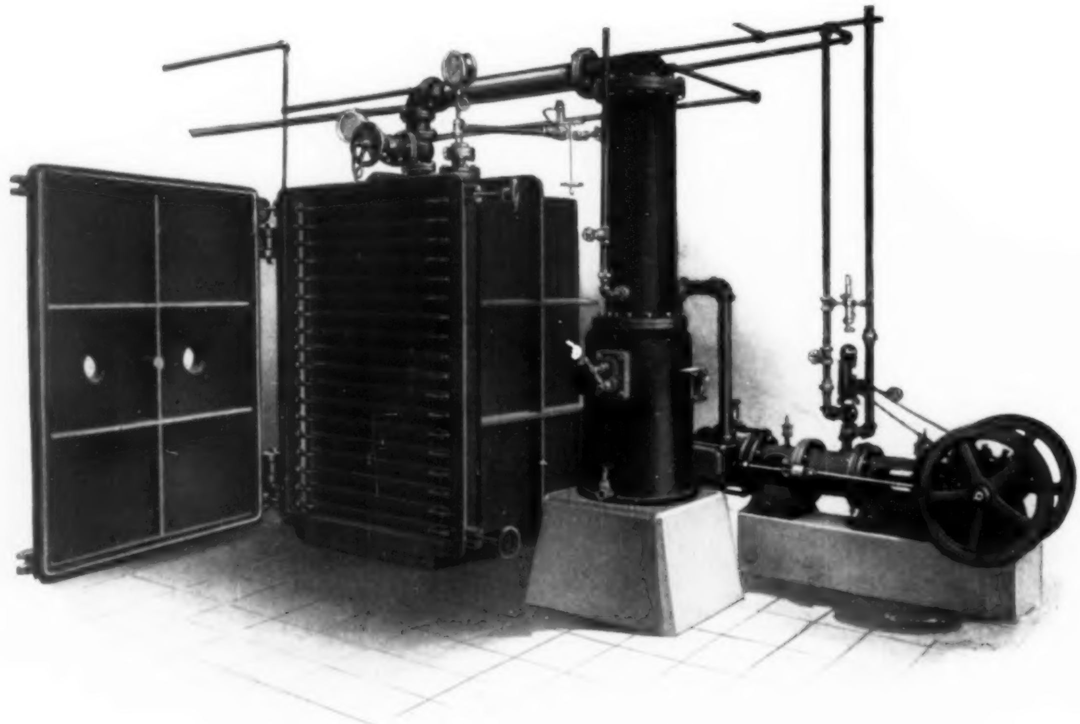
Equipped with one large receiver the full length of apparatus.
Used on materials that will not permit being conveyed when dry.



Vacuum Drum Dryer, No. 1 Size

This apparatus was developed for drying smaller quantities of liquids, pulps, etc., than could be handled economically in our large apparatus. The apparatus also makes a valuable laboratory drum dryer. It is built with casing, receiver, dust collector, etc., of cast iron, cast aluminum or cast bronze as required for different materials being dried.

BUFFALO FOUNDRY AND MACHINE COMPANY



"Buflovak" Vacuum Shelf Dryer

The "Buflovak" Vacuum Shelf Dryer is adapted to the drying of any material that can be handled in pans or trays such as sheet and reclaimed rubber of all kinds, rubber compounds, paints, dyes, extracts, pastes, glue, soap, salts, albumens, of all descriptions, starch, glutrin, rosin, vegetables, fruits, sugars, small electrical apparatus, plates, chemicals, various by-products and liquid substances.

This dryer consists of a rectangular chamber containing hollow, steam or hot water heated, shelves, placed one above the other. The material to be dried is loaded in pans or trays which are placed on the shelves. The apparatus is then closed, the vacuum produced, and the drying commenced. If desired, the volatile matter or solvents removed from the material may be reclaimed. This type of dryer is used very extensively in many industries and is adapted to the drying of a large class of materials.

With the apparatus is furnished a vacuum pump and condenser, to produce and maintain a high vacuum during the drying operation. If the drying is to be done at an extremely low temperature, hot water is used as a heating medium, in which case we supply the apparatus with a hot water circulating system.

Vacuum Shelf Dryer—*Continued*

Special Features

A distinctive feature of the "Buflovak" Shelf Dryer is the construction of the chamber casting, which, in all sizes is made in one piece. This eliminates many joints which would otherwise be necessary. The metal used is a special quality of air furnace iron known as "gun-iron," a dense, homogeneous metal, high in tensile strength; qualities that are essential in the construction of dryers for high vacuum work.

The heating shelves are made of hydraulic straightened steel plates, joined together by seamless welds. Baffle plates are placed between the upper and lower plates of shelves to insure the proper distribution of steam, so that the shelves will be uniformly heated throughout. All shelves are constructed for a working pressure of 60 pounds and tested to 150 pounds pressure before being assembled in the dryer.

The steam manifolds are made of XX steel pipe, avoiding the breakage experienced where cast manifolds are used. The manifolds in our apparatus face outward, making it easy to disconnect or connect a shelf at any time it is found necessary. The manifolds are connected to the shelves with ground joints, which eliminates the use of packing.

Expansion and contraction of the shelves are taken care of both endways and sideways, and it is impossible to throw any strain, through this cause, on the manifolds or shelves.

To break the vacuum, a four-way cored opening is contained on the inside of the door, which evenly distributes the incoming air over the apparatus and does not permit blowing of the material being dried. The apparatus is designed with a large factor of safety and is built of the highest quality of material and workmanship.

TABLE OF STANDARD SIZES

Class	Width of Shelf, Inches	Length of Shelf, Inches	Number of Shelves	Space Between Shelves, Inches	Pan Surface, Square Feet	Number of Shelves	Space Between Shelves, Inches	Pan Surface, Square Feet	Number of Shelves	Space Between Shelves, Inches	Pan Surface, Square Feet	Number of Shelves	Space Between Shelves, Inches	Pan Surface, Square Feet	Number of Shelves	Space Between Shelves, Inches	Pan Surface, Square Feet	Number of Shelves	Space Between Shelves, Inches	Pan Surface, Square Feet	Number of Shelves	Space Between Shelves, Inches	Pan Surface, Square Feet	Number of Shelves	Space Between Shelves, Inches	Pan Surface, Square Feet	Weight of Dryer (See Note Below) Minimum Lbs.	Maximum Lbs.
A	18	18	1	4½	2¼																						800	
B	24	24	2	5½	4	3	2½	8																			1100	1175
C	42	42	3	6½	22	4	4½	33	5	3⅝	44	6	2½	55													3800	4450
D	42	42	6	5	55	7	4	66	8	3½	77	9	2⅞	88	10	2½	99										5600	6470
E	42	42	8	6	77	9	5	88	10	4½	99	11	4	110	12	3 9/16	121	13	3	132	15	2 9/16	154				7430	8970
F	42	42	11	5½	110	12	5	121	13	4½	132	14	4	143	16	3⅜	165	17	3	176	20	2½	209				8650	10650
G	60	80	9	5⅜	240	10	4½	270	11	4⅛	300	12	3⅝	330	13	3¼	360	14	2⅞	390	15	2⅝	420	16	2⅜	450	19500	23750
H	60	120	9	5⅜	360	10	4½	405	11	4⅛	450	12	3⅝	495	13	3¼	540	14	2⅞	585	15	2⅝	630	16	2⅜	675	26000	32200
I	60	160	9	5⅜	480	10	4½	540	11	4⅛	600	12	3⅝	660	13	3¼	720	14	2⅞	780	15	2⅝	840	16	2⅜	900	33000	41600
J	60	80	12	5	330	13	4½	360	14	4	390	16	3½	450	18	3	510	19	2¾	540	20	2½	570				23000	27900
K	60	100	12	5	412½	13	4½	450	14	4	487½	16	3½	562½	18	3	637½	19	2¾	675	20	2½	712½				26800	32500
L	60	120	12	5	495	13	4½	540	14	4	585	16	3½	675	18	3	765	19	2¾	810	20	2½	855				31100	38200
M	60	140	12	5	577½	13	4½	630	14	4	682½	16	3½	787½	18	3	892½	19	2¾	945	20	2½	997½				35500	43900
N	60	160	12	5	660	13	4½	720	14	4	780	16	3½	900	18	3	1020	19	2¾	1080	20	2½	1140				39850	49600

Shelf Dryers are designated by the class letter followed by the number of shelves. Example, "F-20" designates an "F" dryer with 20 shelves.

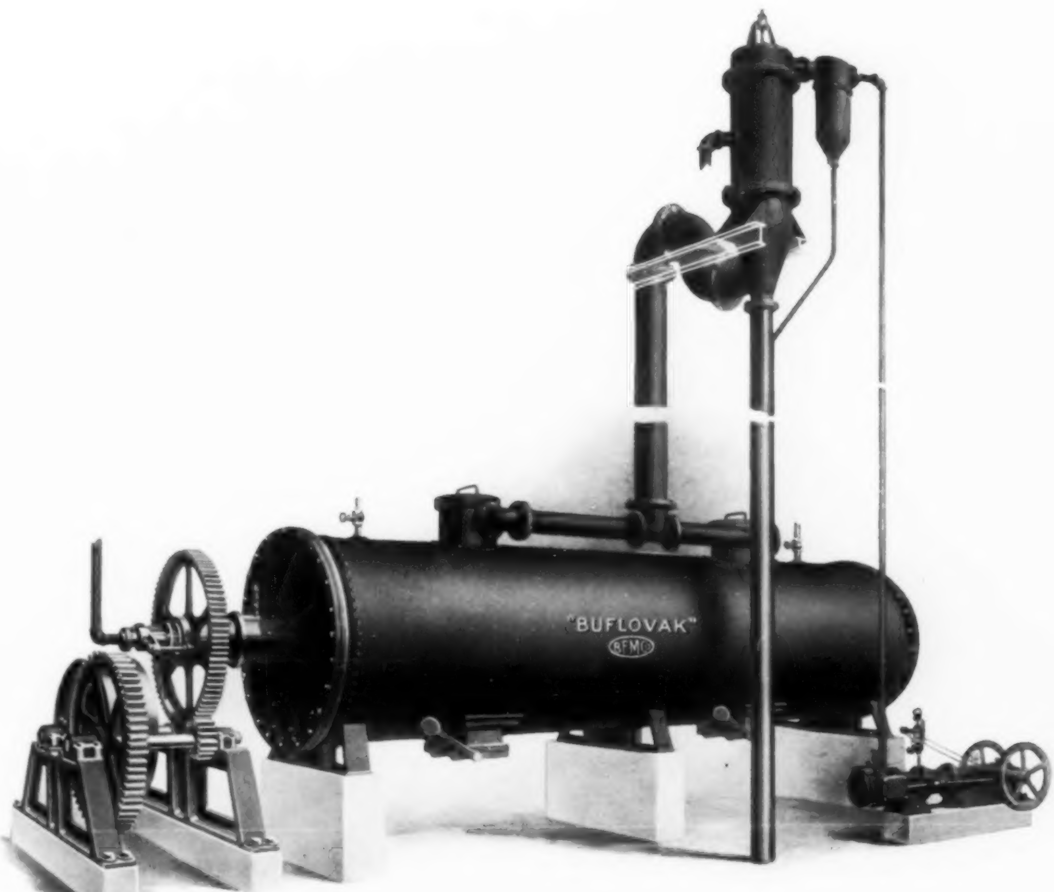
The spacing and number of shelves may be changed up to the limit of the chamber.

The minimum weight given above is for the dryer with the lowest number of shelves in that class. The maximum weight is for the dryer.

All shelves are 1 inch thick, excepting the "A" size, which is steam jacketed.

All dryers from "A" to "F" inclusive have one door. All dryers from "G" to "N" inclusive have two doors, one at each end of the dryer.

1543 FILLMORE AVENUE, BUFFALO, NEW YORK



"Buflovak" Vacuum Rotary Dryer

Complete with Vacuum Pump, Barometric Condenser, etc.

The Vacuum Rotary Dryer is used for drying semi-liquids and materials in granular form, such as reclaimed rubber, rubber compounds, chemicals, by-products, starch, cereals, fertilizer, dextrine, or any material that permits tumbling or mixing while being dried.

The dryer consists of a hollow, steam-jacketed cylinder fitted with heads at each end. In the center of the cylinder is a revolving heating tube carrying arms and paddles which effect a tumbling over or mixing of the material being dried. The dryer can be operated in connection with a barometric or surface condenser, depending on the amount of moisture or solvents

"Buflovak" Vacuum Rotary Dryer—*Continued*

being drawn from the material being treated and also whether or not it is desired to reclaim them.

In operation steam is supplied to the jacket of the casing and to the inner revolving tube. The space between the revolving tube and the jacketed shell, after being loaded with the material to be dried, is evacuated. This vacuum causes a rapid evaporation of the moisture and other solvents contained in the material. The vapors pass to the condenser where they are condensed and either thrown away or reclaimed as desired.

A distinctive feature of the "Buflovak" Rotary Dryer is the construction of the jacketed shell and the inner revolving tube. These are made of lap-welded steel tubing instead of the welded or riveted steel plate construction. The lap-welded construction, being more regular and free from joints or rivets, permits the paddles to be set close to the shell, and greatly increases the efficiency of the dryer.

For drying most materials the outer casing consists of the construction above described, but for materials which tend to adhere to the shell, the outer casing is made of cast gun-iron, cast with a jacket between two shells. This construction permits the inside to be machined the full length. This is done so that the paddles or scrapers can be set close to the shell to prevent material adhering to the shell while drying.

For loading, the dryer contains one or more large openings at the top which are fitted with cast iron covers. When necessary these covers are also supplied with an observation glass. The unloading apertures, one or more in number, are placed at the bottom of the shell. These consist of doors, properly hinged and counterbalanced. The doors are flush with the inner shell of the dryer so that no material can lodge in the unloading apertures when the doors are closed. Any of our dryers will unload the charge in a few minutes, but for ease in loading and unloading, it is desirable to so place the apparatus that it can be charged from and discharged into hoppers which can be connected with conveying devices, etc.

The "Buflovak" Rotary Dryer is frequently used as and makes a very efficient percolator, mixer, evaporator, cooker, etc. Where cooking is desired prior to drying, the same may be accomplished by doing the cooking before a vacuum is created in the apparatus. After it is cooked, the material can be dried in the same apparatus.

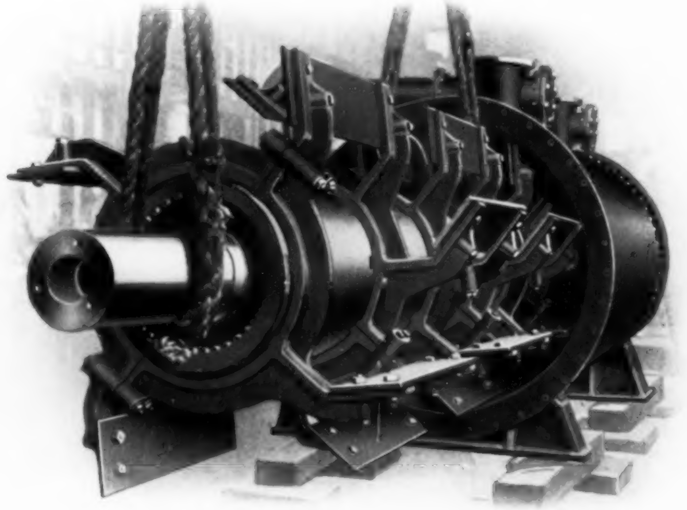
TABLE OF STANDARD SIZES

Size	Inside Diameter	Inside Length	Approximate Outside Dimensions			Approximate Weight
			Length	Width	Height	
R- 1	2′	4′	7′	4′	5′	1800 lbs.
R- 2	3′	6′	10′	7′	8′	10500 "
R- 3	3′	10′	14′	7′	8′	14500 "
R- 4	3′	15′	19′	7′	8′	19000 "
R- 5	3′	20′	25′	7′	8′	24000 "
R- 6	5′	10′	17′	10′	11′	23000 "
R- 7	5′	15′	22′	10′	11′	30000 "
R- 8	5′	20′	28′	10′	11′	38000 "
R- 9	5′	25′	33′	10′	11′	46000 "
R-10	5′	30′	39′	10′	11′	55000 "

SPECIAL SIZES BUILT FOR SPECIAL CONDITIONS

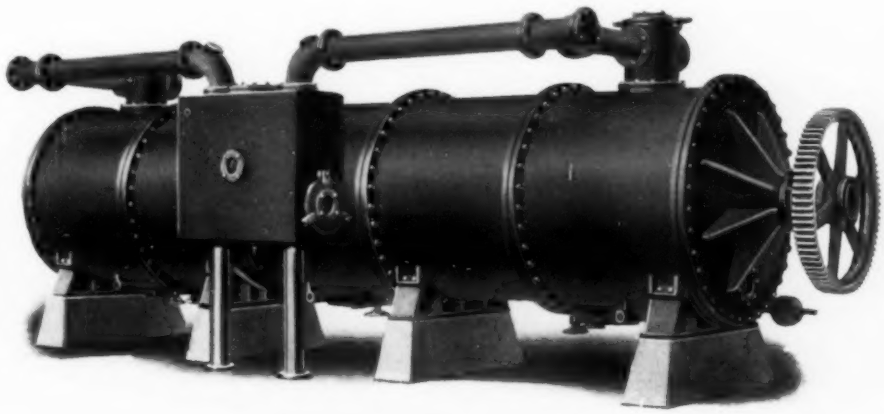
The above outside dimensions allow for a foundation of sufficient height to open the unloading doors above the floor, except the 2′x4′, which is placed on cast iron stands of the proper height.

The weights given are for steel tube construction. If cast iron shell is used, weight will be heavier.



Interior of Vacuum Rotary Dryer

Showing center heating tube, carrying paddles.
Note heavy, rigid, permanent construction.



Vacuum Rotary Dryer

With cast iron outer jacketed casing. Used for materials which tend to adhere to shell. By making the casing of cast iron, the construction is exceptionally rigid and permits the inside to be machined the full length. This is done so that the paddles or scrapers can be set close to shell to prevent material being dried, such as garbage, etc., adhering to the shell.

BUFFALO FOUNDRY AND MACHINE COMPANY

"Buflovak"
Vacuum Drying and Impregnating Apparatus

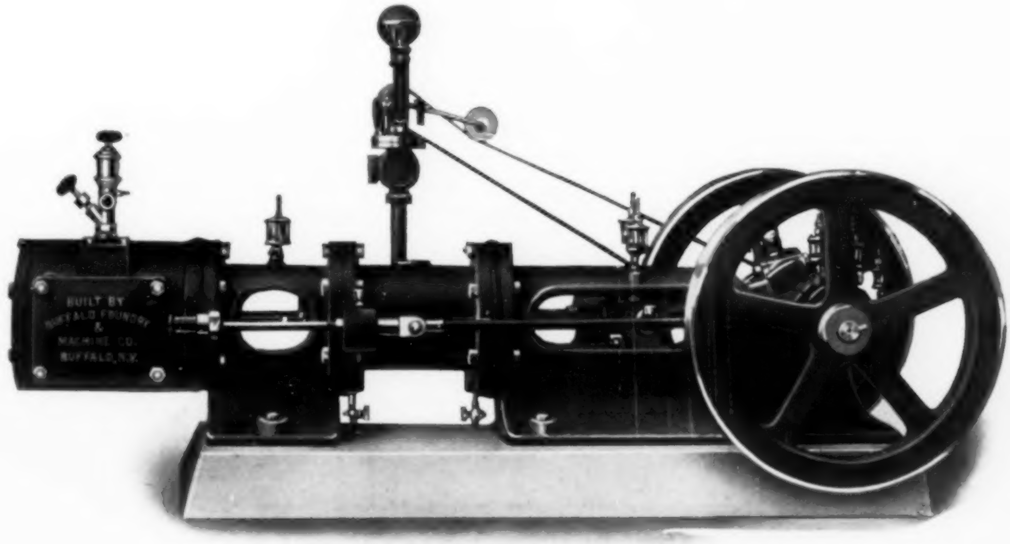
Used for drying under vacuum, and impregnating with insulating compound, electric coils, cables, transformers, armatures and other electrical work; for impregnating any material with paraffine, creosote, oils, colors, waterproofing compounds, and other liquids; for impregnating wood with stain or color, making imitations, which escape detection, of mahogany, cedar and other woods.

The apparatus consists of two or more tanks heated by steam, gas or oil, the tanks being connected at the bottom. Attached to the tanks are a condenser and vacuum pump. The illustration shows our cast gun iron steam-jacketed type, cast in one piece with jacketed side and bottom. This construction eliminates all interior joints and insures a smooth inside surface. The apparatus is so arranged that additional tanks may be added to the installation whenever desired, all being connected to the same pump and condenser. When desired the liquor tank is equipped with a stirring device.

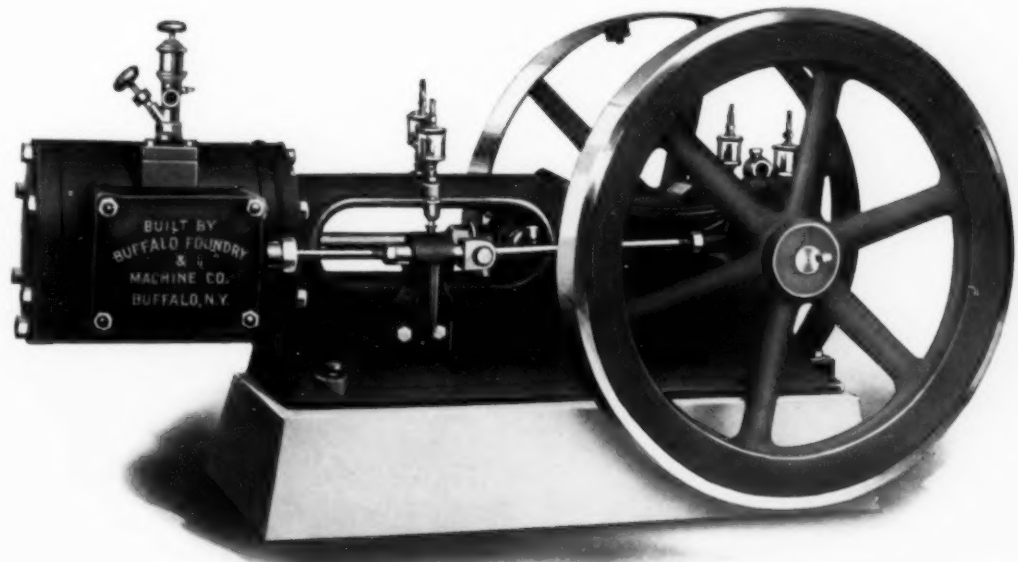
The materials to be treated are placed in the impregnating tank and are rapidly dried under vacuum. After the air and moisture are removed from the pores of the material the compound is admitted to the liquor tank until the material is thoroughly covered, after which the compound is forced into the evacuated pores under pressure until they are thoroughly filled. The material being treated may then be taken out or, if desired, redried under vacuum. Any valuable solvents may be reclaimed. Built in various sizes.

1543 FILLMORE AVENUE, BUFFALO, NEW YORK

"Buflovak" Dry Vacuum Pumps

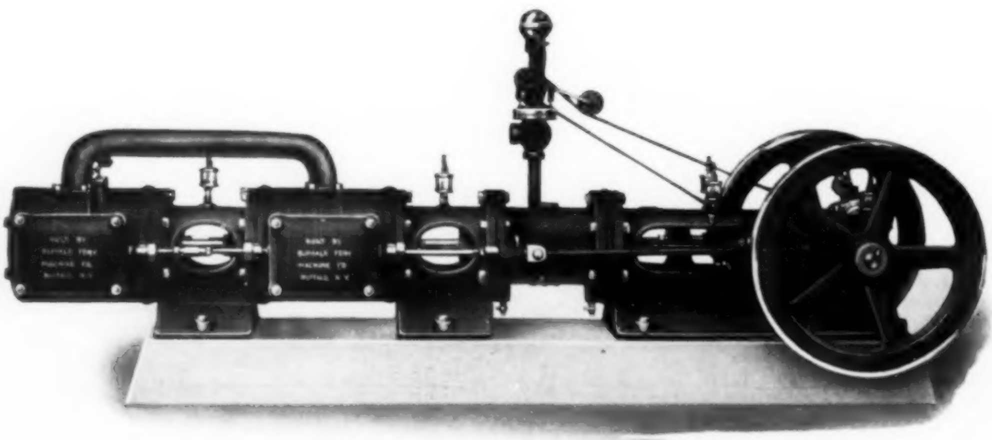


Single Stage, Steam Driven

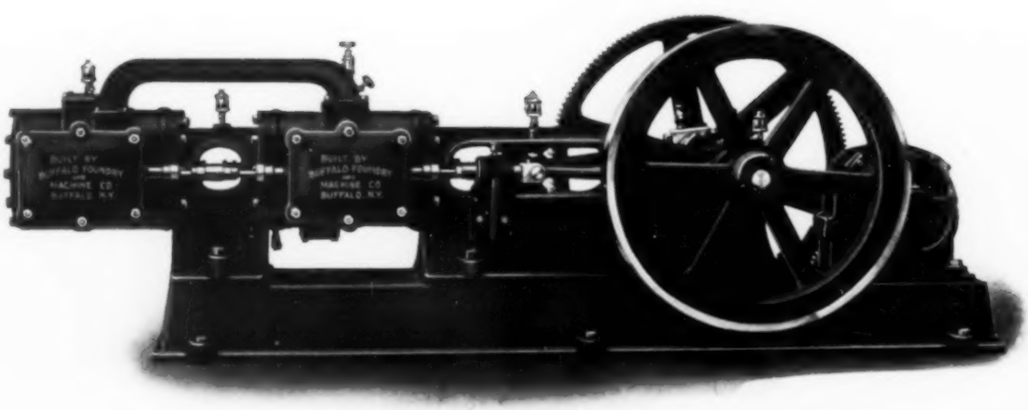


Single Stage, Belt Driven

"Buflovak"
Dry Vacuum Pumps



Two Stage, Steam Driven



Two Stage, Motor Driven

This cut shows method of attaching motor and sub-base to any of our horizontal two stage pumps.

"Buflovak" Dry Vacuum Pumps

The efficiency of a vacuum apparatus depends largely upon the vacuum pump. Rapid evaporation at a low temperature necessitates the maintenance of a high vacuum. "Buflovak" Pumps are designed and built with this end in view.

All our pumps are of the straight line flywheel type, with mechanically operated slide valves. Air valves are self-seating, without springs, and embody special features, including a specially constructed by-pass for rarefying the air left in the clearance space at the end of the stroke. The air valve is also fitted with a unique silent plate exhaust valve in place of the old style poppet valve. This exhaust valve has a long life, is very efficient, and is absolutely noiseless in operation, whereas the old style poppet valve has a very short life, is noisy and causes considerable trouble from breakage.

The air cylinders are cooled by water jackets. This assists in the production and maintenance of an extremely high vacuum. Air pistons are fitted with three rings, and the steam pistons with two. All bearings are of a high grade bronze or babbitt-metal, of ample proportions and are adjustable for wear, thus insuring a long wearing quality.

The positive length of stroke, together with the positively operated valves, allow as high a rotative speed as is consistent with good practice in any reciprocating type of steam engine.

A low steam consumption is made possible by an early cut-off, which is obtained by this type of pump.

"Buflovak" Dry Vacuum Pumps are built in various sizes, horizontal and vertical; single and two stage; steam, belt and motor driven.

STANDARD SIZES OF DRY VACUUM PUMPS

Bore of Steam Cylinder	Bore of Air Cylinder	Stroke	Cubic Feet of Free Air per Minute	R.P.M.	Suction	Discharge	Diameter of Fly-Wheel	Size of Pulley on Belt Driven Pumps	
								Dia.	Face
4	5	5¼	11	100	1¼"	1¼"	18"	24"	4"
7	8½	7	45	100	1½"	1¼"	24"	30"	4"
7	10	10	90	100	3"	2½"	46"	36"	6"
7	12	10	130	100	3"	3"	36"	36"	8"
8	12	12	157	100	3½"	3"	36"	48"	8"
8	14	12	211	100	5"	3"	48"	54"	8"
10	16	12	276	100	6"	4"	48"	60"	8"
10	16	16	367	100	6"	4"	56"	60"	8"
10	18	16	463	100	8"	6"	56"	72"	8"

The first pump listed is of the Vertical type. All others are of the Horizontal type.
All pumps are furnished in the belt driven or steam driven types. The steam cylinder is omitted on the belt driven type and the pulleys are omitted on the steam driven types.
All pumps are furnished in the two-stage type, when desired, in which case the second air cylinder is the same size as the one given in the table.

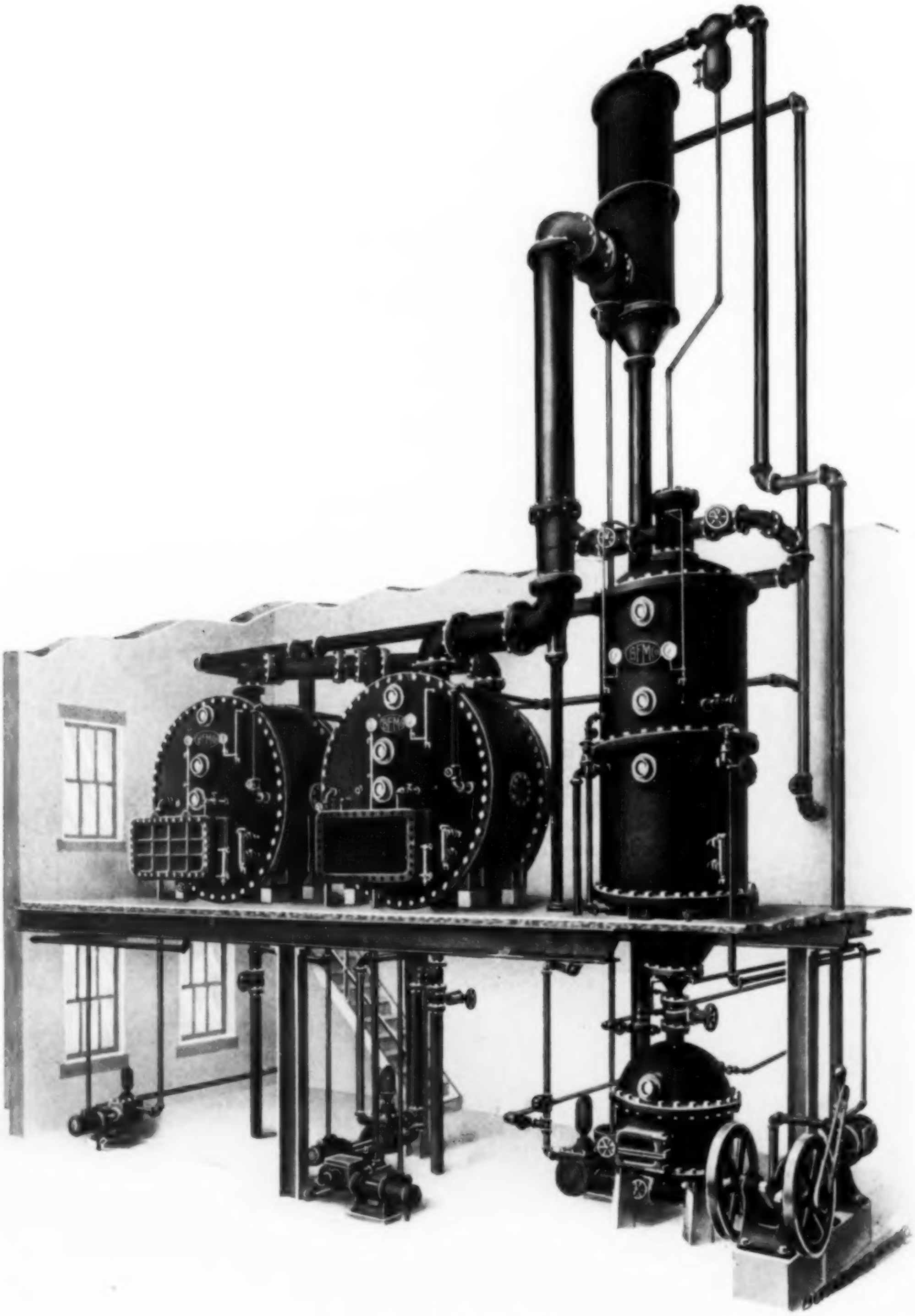
"Buflovak" Surface Condenser Without Receiver

This condenser consists of a tube section. The hood at the top is provided with two openings, one for the air and vapors to enter, and the other for the exhaust. These openings enter into compartments at the top, which are divided by a wall, causing any air, vapors or gases entering one pipe to be forced down through a number of the tubes to the bottom of the tube section, and return through the balance of the tubes to the top, at which point the air, separated from the vapor, leaves the condenser. This condenser is usually placed vertically, but may be used horizontally if desired. Where it is used in a vertical position, it is supplied with legs for supporting it at a sufficient height above the floor to permit placing a container underneath, in which liquids may be reclaimed from the condenser and the container easily removed from the bottom of the condenser. The legs or stands may be left off and the condenser drain piped where desired.

"Buflovak" Expansion Tank

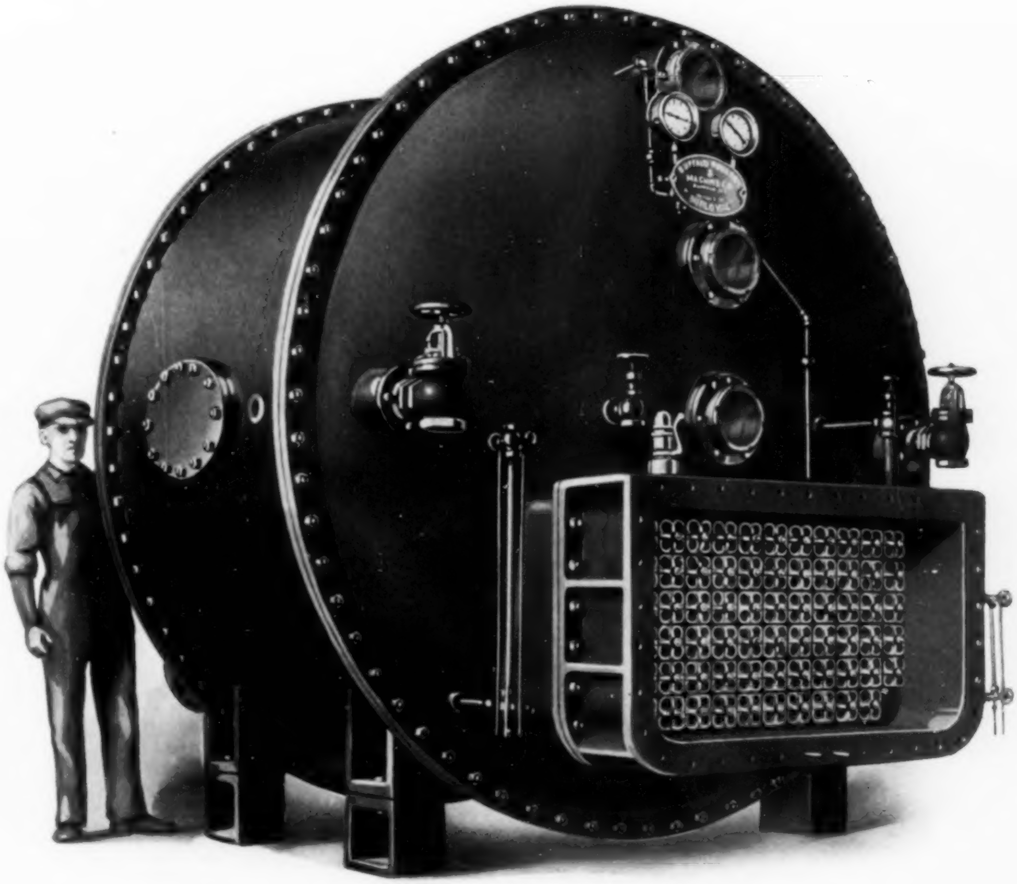
Used in connection with a dry vacuum pump, to collect and reclaim highly volatile vapors, which sometimes pass through the cylinder of the vacuum pump with the exhaust air from a vacuum apparatus. These expansion tanks are built in various sizes to meet various conditions.

BUFFALO FOUNDRY AND MACHINE COMPANY



"Buflovak"
Triple Effect Evaporator

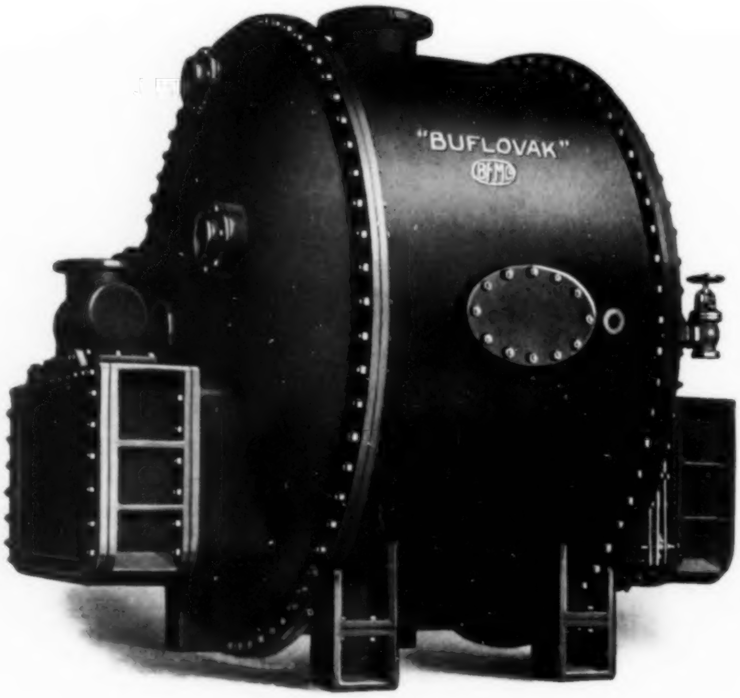
1543 FILLMORE AVENUE, BUFFALO, NEW YORK



Front View

"Buflovak"
Horizontal Tube Evaporator

BUFFALO FOUNDRY AND MACHINE COMPANY



Rear View

"Buflovak"
Horizontal Tube Evaporator

This type of construction has been developed from the old "Wellner-Jelinek" evaporator which was designed more than sixty years ago for the concentration of beet sugar juice. The former rectangular shell made of straight plates has been changed to a circular shell. The advantages are obvious.

Fig. 1 shows the general construction of the "Buflovak" H. T. Evaporator. The horizontal cylindrical shell is closed at both ends by spherical heads, and the evaporator body will therefore resist any inside or outside pressure, without the necessity of excessive wall thicknesses. The number of joints and therefore the chance for leakage is less than in any other type, as the cylindrical shells can be made in one piece up to a length of 12 feet.

Rectangular shaped steamheaders are bolted to the spherical heads and the heating tubes are secured in cast iron flue plates by taper shaped rubber gaskets and bolted packing plates, or expanded in steel flue plates like ordinary boiler tubes. The rear header is slightly higher than the front header so that the condensation in the tubes will readily drain towards the front. The steam enters the rear header through a manifold on top, making it possible to distribute the steam or vapor evenly over all the tubes. The front header has an outlet for the condensation at the bottom, and an opening at the top for the removal of the non-condensable gases.

Horizontal Tube Evaporator—*Continued*

At each side of the rectangular nest of heating tubes is placed a partition plate. Width of the tube nest and diameter of the evaporator are of such proportions that a large downtake of uniform width is left on both sides. The liquor boiling up between the tubes is given a chance to return to the bottom of the evaporator through the downtake, permitting a rapid and uniform circulation through all parts of the heating surfaces. The liquor passes the tubes at high speed, keeps them clean by the scouring action, and therefore eliminates the necessity of frequent cleaning.

Losses by entrainment are generally caused by excessive vapor speed, and this difficulty has been overcome by making the width of the evaporator body, above the liquor level, about twice the width of the tube nest. How important this extra width is may readily be seen from the fact that the losses increase with the square of the speed, other conditions being equal.

The peculiar construction of the evaporator will also greatly reduce the losses, on account of foaming, which is sometimes unavoidable in this type of evaporator. The best way to stop foaming is to lower the liquor level and reduce the quantity of liquor in the pan. The illustration shows quite clearly that the amount of liquor will diminish very quickly when the level is lowered.

Another very important feature of the "Buflovak" Type is the possibility of increasing the capacity of the evaporator by adding another belt to the present shell. Quite frequently it is found desirable to enlarge the plant after a short period of operation, and generally it means an entire new plant. Not so with the "Buflovak," where only the additional belts and new tubes have to be purchased.

The H. T. Evaporator is built in two standard sizes, 96" and 114" diameter, and the length of the tubes will vary from 6 ft. to 16 ft. The range of heating surface is from 590 to 2460 square feet; also special sizes down to 40 square feet. Apparatus can be built of cast iron, steel, copper, bronze, aluminum; also of cast iron or steel and lined with acid-proof material.

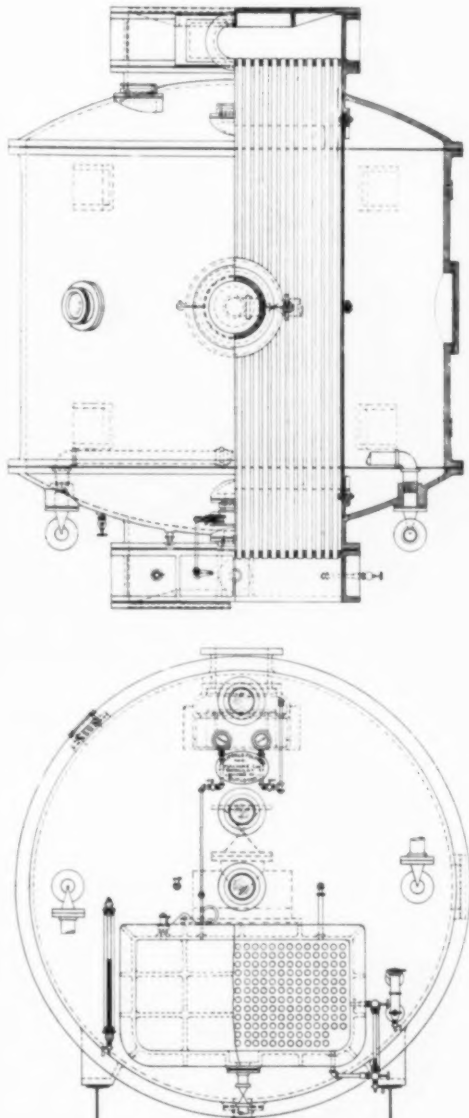
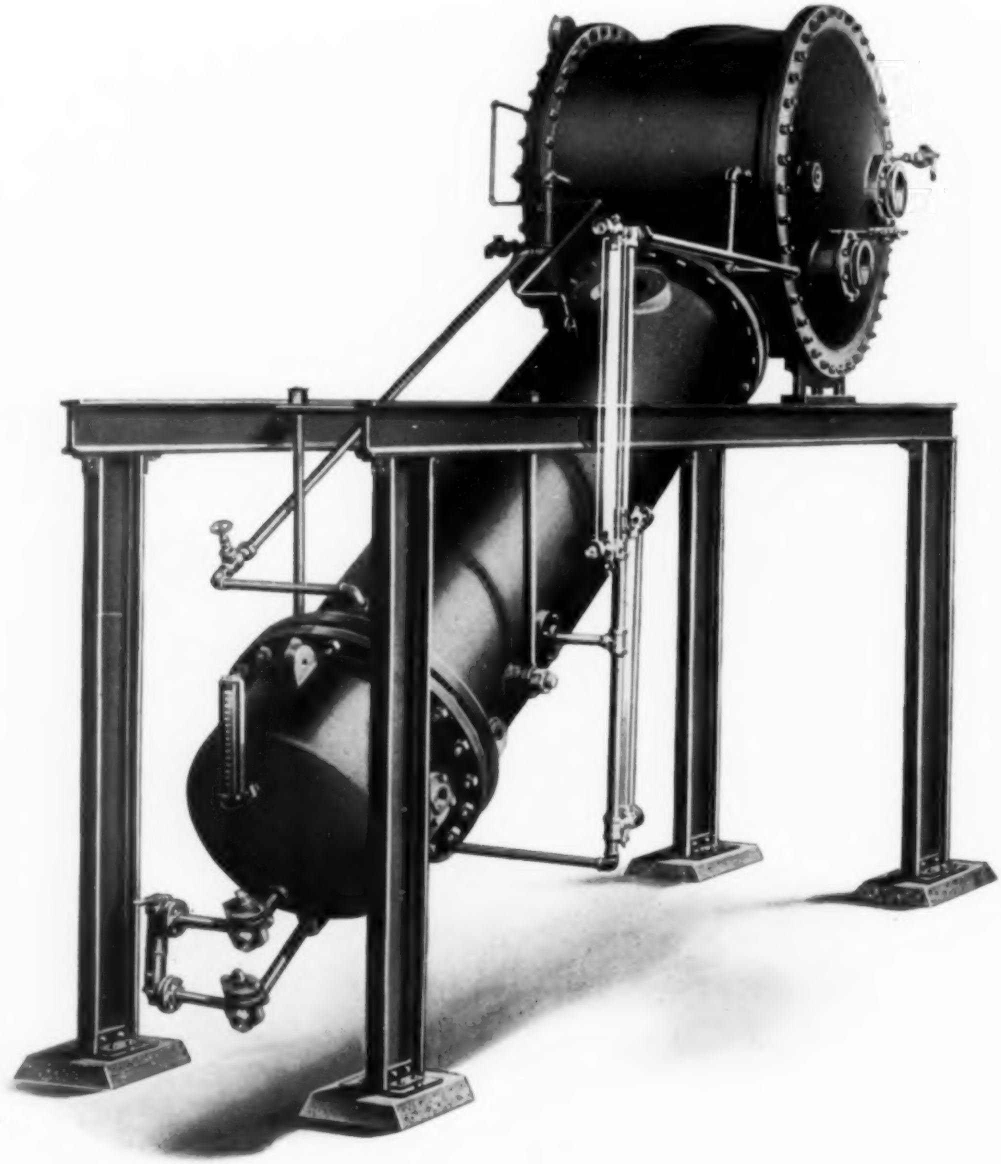


Fig. 1

BUFFALO FOUNDRY AND MACHINE COMPANY



"Buflovak"
Rapid Circulation Evaporator

"Buflovak" Rapid Circulation Evaporator

Semi-Film

The inclined type has been developed from the standard return tubular boiler and adapted for the special purpose of handling foamy and delicate liquors.

The standard type is shown in Fig. 2, and consists of a horizontal cylindrical vapor body and, bolted to it, an inclined cylindrical steam-chest, the end of which is closed by suitable removable cover. The steam-chest is divided by a solid partition into two compartments. The upper large compartment is filled with tubes which are expanded in the flue-sheets, closing both ends. The lower and much smaller compartment, called the downtake, is open at both ends. The steam is around the tubes and the liquor inside the tubes; the vapor and a part of the liquor pass through the upper part of the tubes at a very high speed, and are thrown with great force against the ribs of the baffle plate which extend across the whole cylindrical length of the vapor body. The liquid returns through the downtake to the lower part of the steam-chest while the vapor passes at both ends of the partition plate into the vapor space and from there through the entrainment separator to the next effect or condenser. The amount of liquor in circulation is very small and the possibility of foaming is reduced to a minimum, as the liquor level is always kept rather low and the foam is broken up in the upper part of the tube where film evaporation takes place.

The high speed of the liquor in the tubes (100 feet per second or more) has the tendency to keep the heating surface clean; however, scale can be removed very quickly from the outside after the small cover at the end of the steam-chest has been taken off.

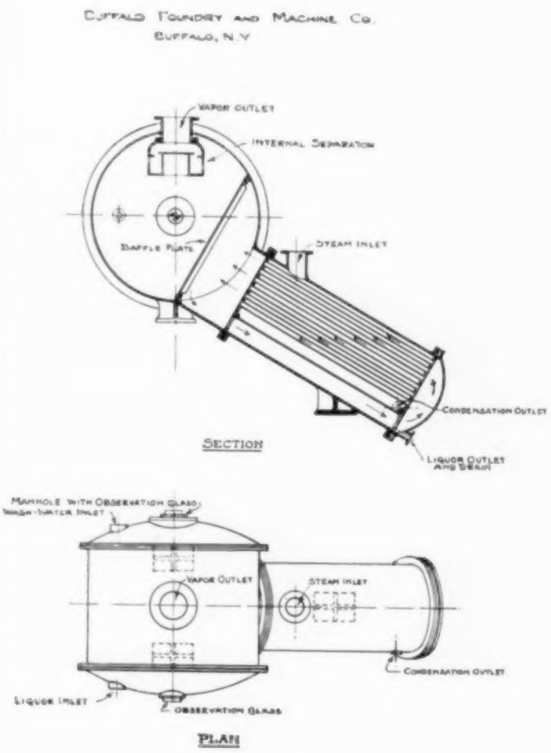


Fig. 2

Rapid Circulation Evaporator—*Continued*

R. C. T. Steam Chests

R. C. T. Vapor Bodies

The illustration shows the construction of the steam-chests with the large downtake for the return of the liquor; all castings are carefully inspected and tested before the steam-chests are assembled.

The inclined Rapid Circulation type is built in five standard sizes with different lengths of steam-chests and the heating surface varies from 130 to 1520 square feet.

In some cases where a rather large heating surface is required, two standard steam-chests are bolted to a single vapor body and the construction of this Duplex type is shown in Fig. 3.

Each steam-chest has separate connections for steam, condensation and liquor, but only one vapor outlet.

A special type of Rapid Circulation

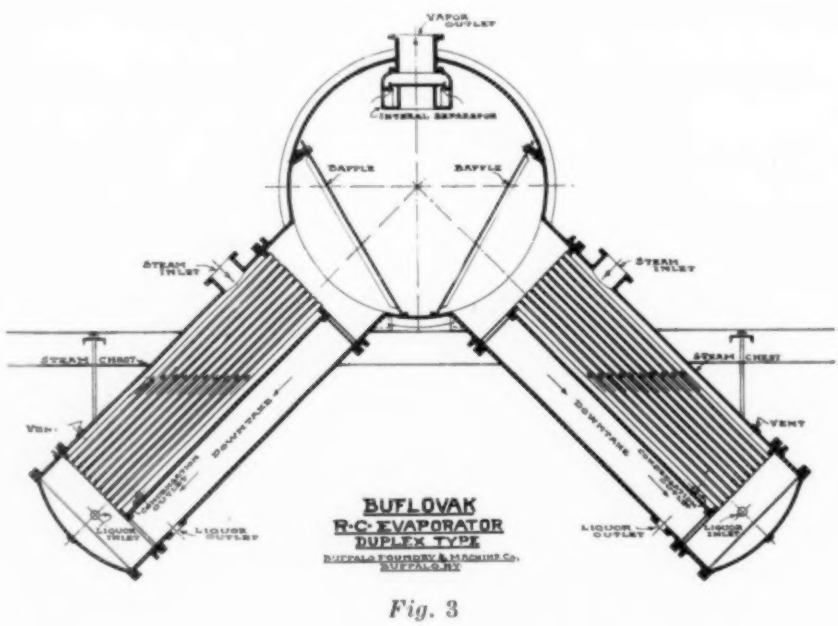


Fig. 3

Rapid Circulation Evaporator—*Continued*

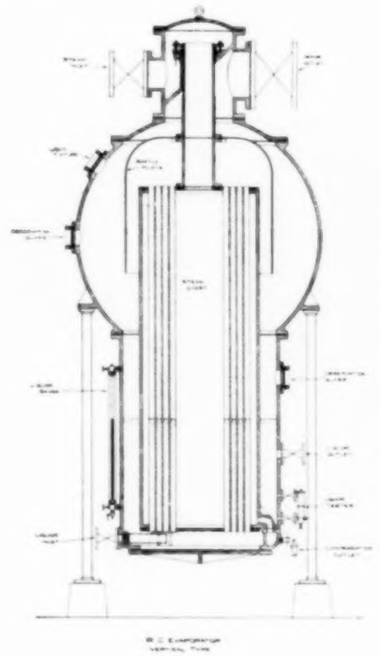


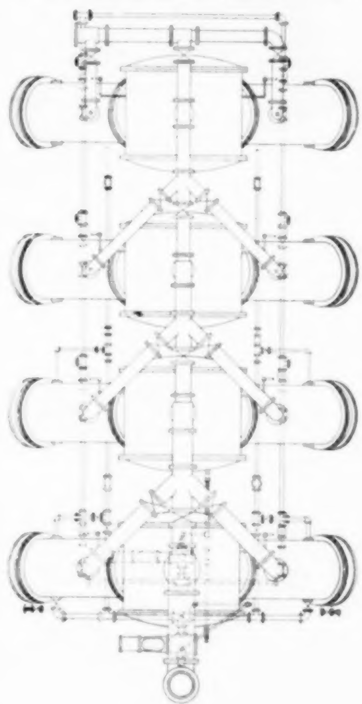
Fig. 4

Evaporator is shown in Fig. 4. This construction has been developed from the standard vertical tube evaporator, increasing the length of the tubes, and reducing the liquor space. Careful experiments, which have been confirmed by practical experience, have shown that the coefficient of heat transmission is highest when the liquor level in the tubes is about one-third of the tube length above the lower flue-plate. The upper part of the tube is covered with a climbing film of liquor, and this accounts for the large capacity of the heating surface. This type is especially suitable for the concentration of thin liquids of foamy nature, or organic solutions which should not be exposed to the heat any length of time. The vapor and liquor which have boiled up in the tubes are returned downwards by the baffle ring; the liquor goes back to the bottom of the steam-chest, while the vapor passes upwards through the large vapor space to the vapor outlet. Entrainment of liquor drops in the vapor is prevented by the change of direction and the reduction of vapor speed as soon as it leaves the baffle ring.

The steam enters the steam-chest from the top through the vapor dome; condensation and non-condensable gases are removed through hollow lugs which at the same time are used as supports for the steam-chest. Top and bottom of the evaporator can easily be removed. Density of the liquor is under perfect control, which is not the case with other evaporators of the climbing film type.

The Vertical Rapid Circulation Type is built in five standard sizes having from 350 to 1700 square feet heating surface. It occupies very little floor space and the erection and operation are extremely simple.

Fig. 5 shows a Duplex Rapid Circulation Quadruple Effect Evaporator handling 9000 gallons of liquor per hour. All pipe lines for vapor, liquor and condensation are equipped with the necessary valves and fittings so that each effect can be cut off without interfering with the operation of the other evaporators.



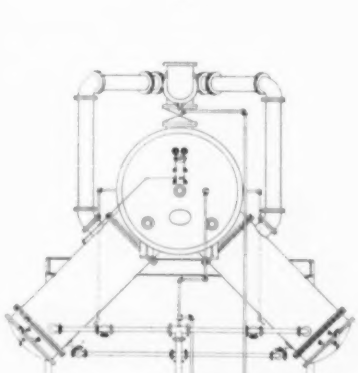


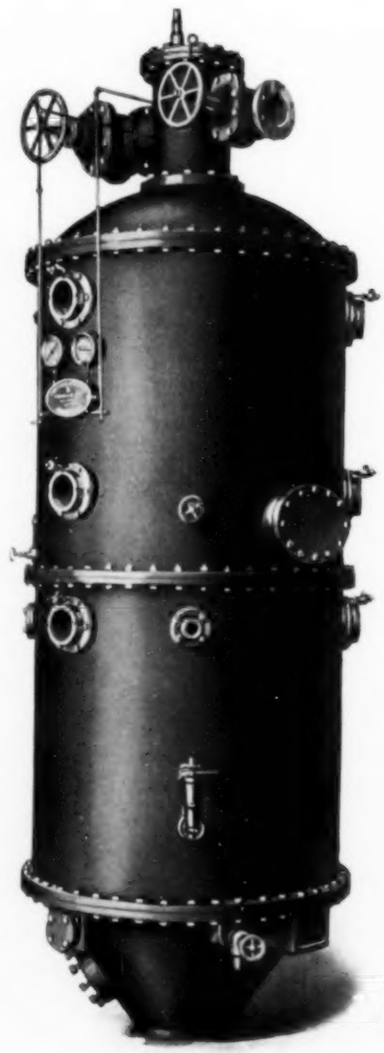
Fig. 5

"Buflovak" Vertical Tube Evaporator

The Mantius Crystallizing Evaporator has been developed from the old standard evaporator constructed seventy years ago by Mr. Fl. Robert. The most important change is in the steam-chest which formerly was an integral part of the evaporator body, but is now a separate unit allowing a better circulation of the steam and liquor. This type is used mainly for liquors with soluble salts which will precipitate during concentration.

The construction is shown in Fig. 6. The evaporator consists of the cylindrical shell with dished head and cone bottom, and the steam-chest of the floating type forming a separate unit; interior of chest is equipped with suitable baffles and channels for the efficient distribution of the steam and separation of non-condensable gases.

The steam entering through the central inlet at the top is readily distributed over the whole heating surface, and the liquor boiling up in the tubes is thrown towards the outer shell where a large annular downtake is left for the return of the liquor to the lower part of the evaporator. The proportions are such that the speed in the tubes is very much higher than in the lower part of the downtake, allowing the salt to settle out before the liquor again reaches the heating surface. The condensed steam and non-condensable gases are removed from the steam-chest through hollow lugs which at the same time serve as supports.



Vertical Tube Evaporator—*Continued*

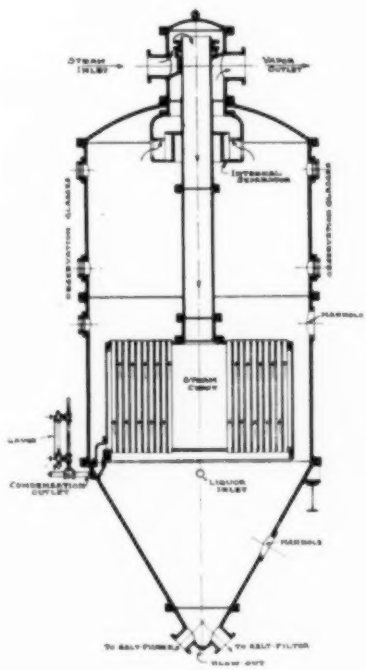


Fig. 6

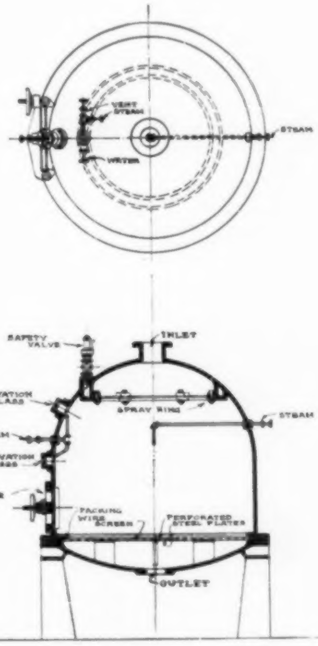


Fig. 7

Steam-Chest for Vertical Tube Evaporator

The precipitated salt passes from the cone bottom into the salt filter, a cross section of which is shown in Fig. 7. As soon as the filter is filled with salt the mother liquor is drawn off and the salt washed with weak liquor, or hot or cold water. If the salt is to be recovered in solid form it is dried by hot air or superheated steam and then removed through the manhole; if the salt is to be used again in a solution it can be dissolved right in the salt filter and discharged by pumping. Where large quantities of salt are to be handled, two salt filters are connected to each evaporator and used alternately.

The Mantius Crystallizing Evaporator is built in twelve standard sizes with a heating surface from 300 to 2440 square feet. The salt filters are manufactured in five sizes having a net capacity of from 300 pounds to 5000 pounds per charge.

Vertical Tube Evaporator—*Continued*

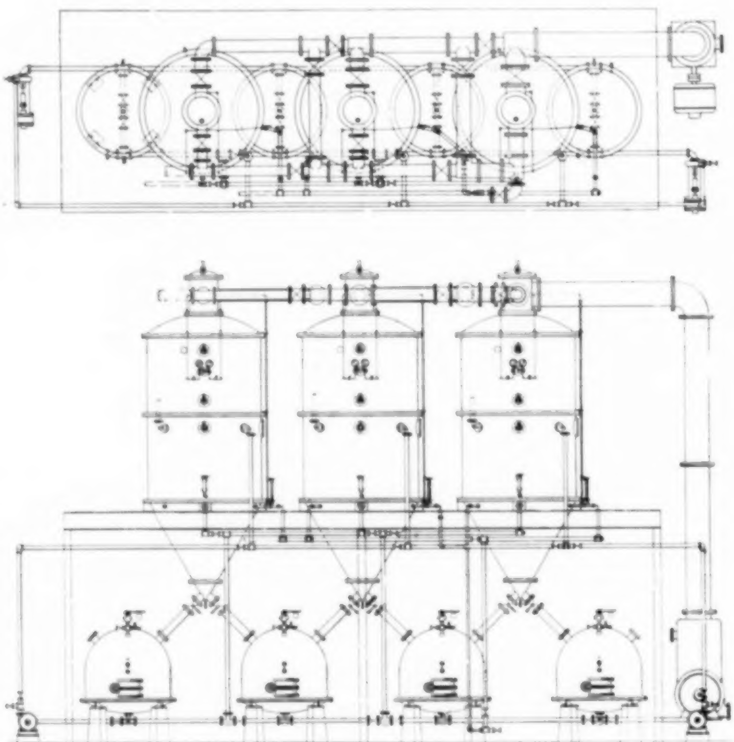


Fig. 8

Fig. 8 shows a triple effect evaporator with four salt filters for a capacity of 2400 gallons per hour. The salt filter will take care of 60 tons of salt per day. The piping is arranged so that each evaporator can be cut off.

A special type of crystallizing evaporator is shown in Fig. 9. The capacity as a double effect is 2500 gallons per hour, and the arrangement is such that the output can be doubled by operating both pans as single effects. The height of the evaporators, and therefore, the liquor levels, is such that the mixture of liquor and salt crystals is discharged by gravity against the vacuum into the receiver and from there into the rotary salt filters. The dry salt is scraped from the drum continuously while the mother liquor is returned to the feed tank. The finished liquor which has been freed from the salt in the settling space of the evaporator is discharged by gravity into a storage tank.

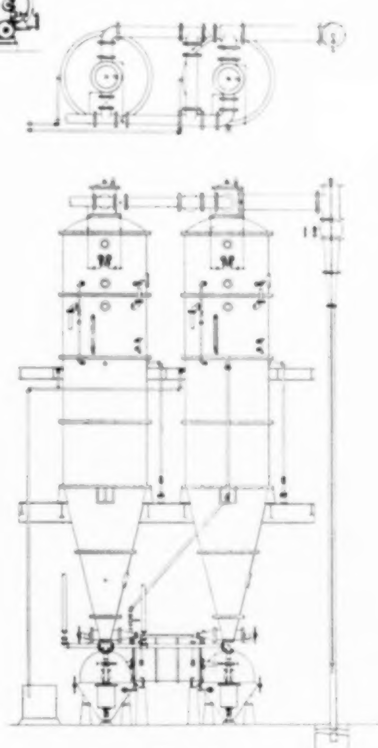


Fig. 9

"Buflovak" High Concentrator

This type is of special design and is protected by U. S. Letters Patent granted several years ago to Mr. O. Mantius, the manufacture of which is now controlled by us.

The construction is shown in Fig. 10. The concentrator consists of three parts: vapor body, liquor body and steam-chest, which is again divided into the steam compartment and condensed water section. The heating surface consists of special tubes of about 4" diameter with closed top. The steam passes from the steam-chest through a small pipe to the top of the heating tube. The condensation and non-condensable gases are driven into the upper chamber of the steam-chest and from there discharged separately. The tubes are spaced very close together leaving a large downtake in the center. This arrangement will cause a very rapid, uniform circulation of the liquor and makes it possible to concentrate to very high densities that are not obtainable in ordinary evaporators. The apparatus can also be used for liquors separating salts and especially caustic solutions at higher densities where an all cast-iron construction is absolutely necessary. The tubes can be made of cast iron, copper or special bronze. Special care has been taken that the number of joints is reduced to a minimum and that all machined surfaces are protected by special gaskets.

This type is built in four standard sizes with different lengths of tubes and the heating surface will vary from 110 to 660 square feet.

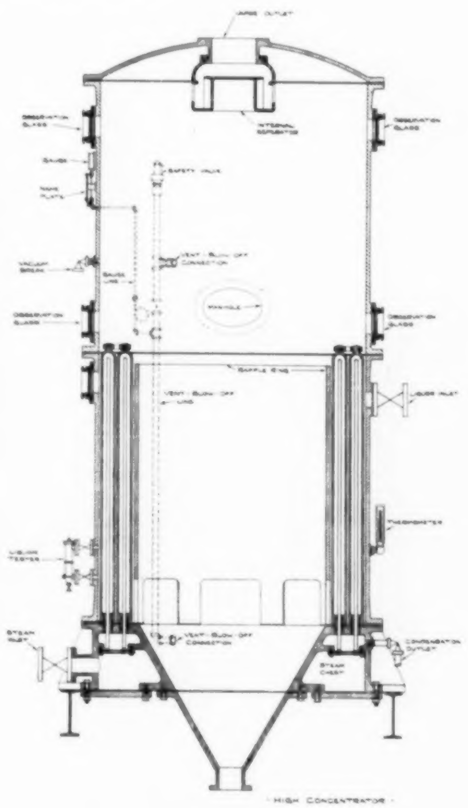


Fig. 10

Tubes for High Concentrator

Accessories
for
"Buflovak" Evaporators

UNLESS otherwise specified, "Buflovak" Evaporators are furnished with complete condensing systems, pipe lines, valves, fittings and pumps. It is general practice to use wet system condensers with wet vacuum pumps for all smaller installations and barometric condensers with dry vacuum pumps for large plants.

Evaporators are equipped with entrainment separators, manholes, hand-holes, electric light openings, observation glasses, gauges for steam, liquor and water, liquor testers, thermometers and vacuum breakers; also automatic liquor level controllers for large installations.

Leaching Batteries and Extractors with bottom discharge for the extraction of solubles from dry substances. Special type for tanning extract with acid proof lining and special large bottom doors.

Causticizing Equipment for the manufacture of caustic soda and potash from carbonate, and also recovery of caustic from waste carbonate or sulphite liquors by caustification.

Continuous process for large quantities, and batch operation for small plants.

Systematic washing of lime sludge.

BUFFALO FOUNDRY AND MACHINE COMPANY

Accessories for "Buflovak" Evaporators

UNLESS otherwise specified, "Buflovak" Evaporators are furnished with complete condensing systems, pipe lines, valves, fittings and pumps. It is general practice to use wet system condensers with wet vacuum pumps for all smaller installations and barometric condensers with dry vacuum pumps for large plants.

Evaporators are equipped with entrainment separators, manholes, hand-holes, electric light openings, observation glasses, gauges for steam, liquor and water, liquor testers, thermometers and vacuum breakers; also automatic liquor level controllers for large installations.

Leaching Batteries and Extractors with bottom discharge for the extraction of solubles from dry substances. Special type for tanning extract with acid proof lining and special large bottom doors.

Causticizing Equipment for the manufacture of caustic soda and potash from carbonate, and also recovery of caustic from waste carbonate or sulphite liquors by caustification.

Continuous process for large quantities, and batch operation for small plants.

Systematic washing of lime sludge.

Lead Burning—A Nation-Wide Service to those seeking Quality

This organization is well directed and financed, and specializes in Lead Burning on a contract basis anywhere in the United States and Canada.

No order is too large or too small.

Our equipment is our own—and our expert men are *retained* by us; not simply hired for the particular work in hand.

We will guarantee our work for Quality—and for Completion within (or before the expiration of) contract time.

From men seeking Quality rather than Cheapness in price, we solicit inquiries.

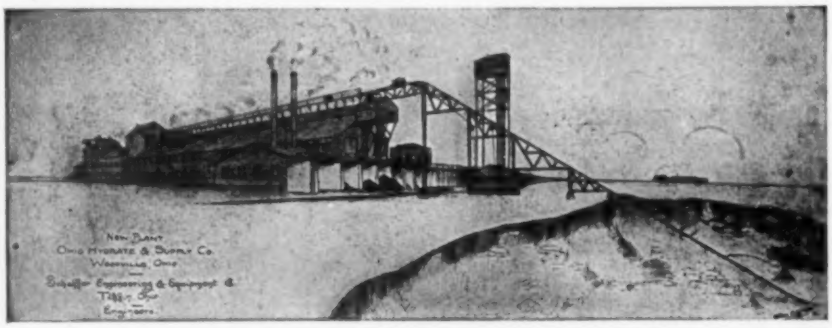
MOORE & SIMONSON, Lead Burning Contractors, 339 Hudson Terminal Bldg. 30 Church St., New York City

Phone 1053 Cortlandt

Brooklyn Office
133 Halsey St.
Phone 5693 Bedford

Shop:
Linden, N. J.

Canadian Representative
H. K. Gray
Traders Bank Bldg., Toronto



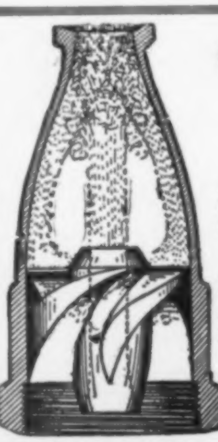
One of the

Schaffer Engineering & Equipment Company's Plants

(Now being constructed)

We are specialists in the design and construction of heavy duty automatic plants for the Cement, Fertilizer, Lime Industries, etc.

The Schaffer Engineering & Equipment Co.
Tiffin, Ohio



"SPRACO" Center Jet Spray Nozzles

The Nozzle is different, and so is the spray it throws

A central jet meets the spirally rotating jets at the orifice, and the result is a finer spray, more of it, with less power required. Ideal for the Chemical and allied industries—washing, spraying, humidifying, cooling, evaporating, reclaiming, etc. Send for Bulletin No. 501.

Spray Engineering Company
Engineers—Manufacturers
Boston, Mass.

Filtration of Zinc Oxide

With the AMERICAN SUCTION FILTER. Large capacity, complete recoveries from Ore Roasters and Furnaces — Automatic Cleaning Device. Results guaranteed constant and reliable.

Write

The CLARK DUST COLLECTING CO.
FISHER BUILDING
CHICAGO, ILL.
Dust Collecting Engineers

CONNERSVILLE

Blowers, Gas Pumps, Water, Vacuum and Liquor Pumps.

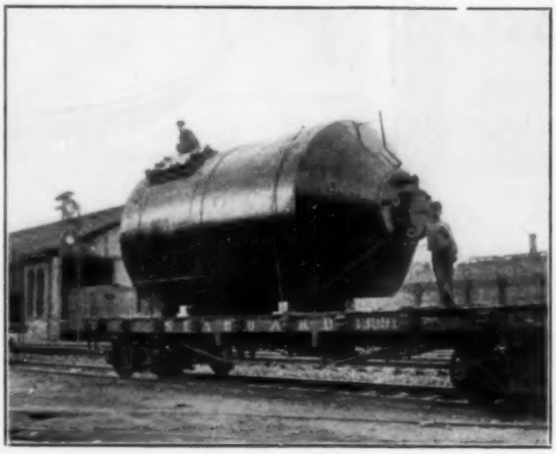
THE CONNERSVILLE BLOWER CO.
Connersville, Ind.
Chicago, 929 Monadnock Blk. New York, 114 Liberty St.

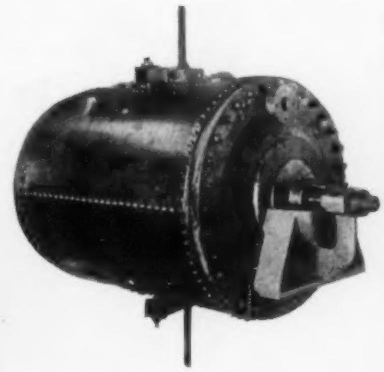
DESIGN
CONSTRUCTION
ERECTION

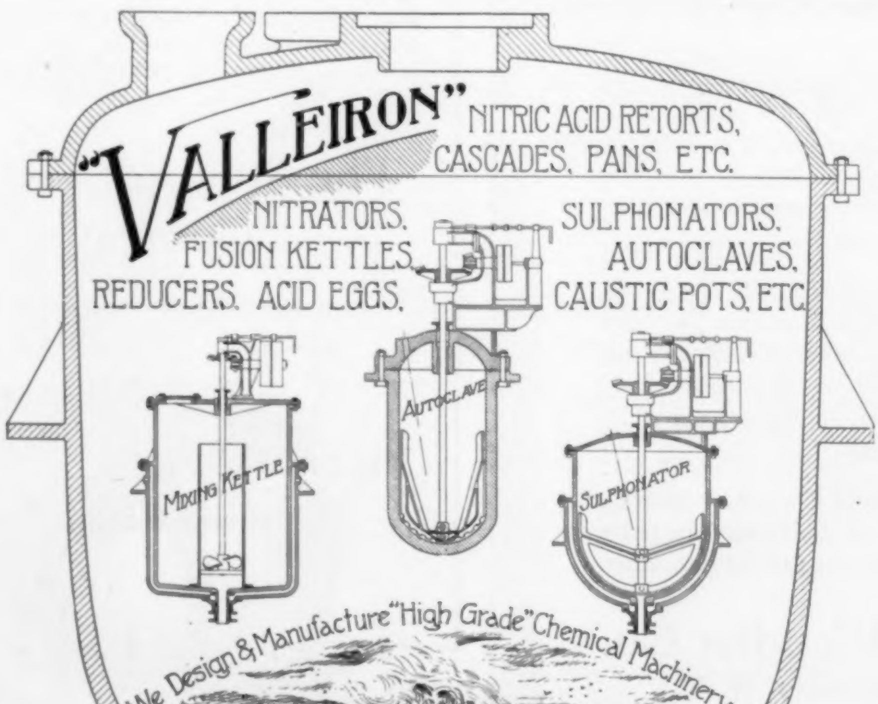
Chemical and Industrial Equipment

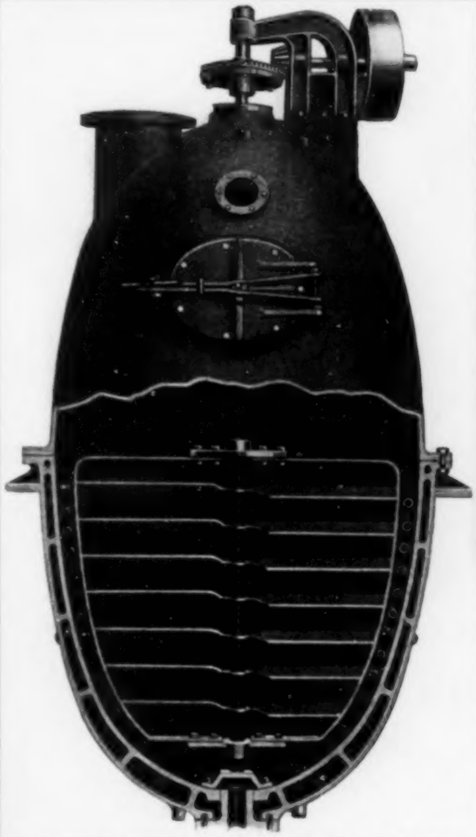
Rapid Delivery — Fine Workmanship

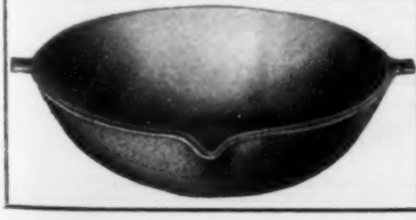
Henry E. Jacoby
Contracting Engineer
95-97 Liberty St., New York

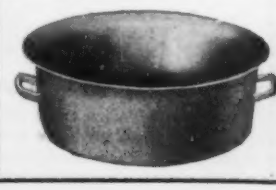


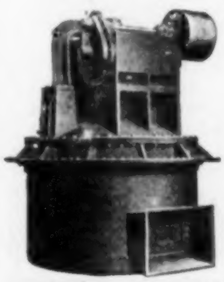


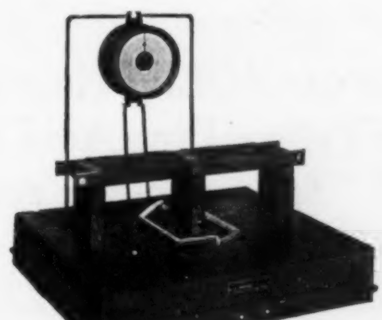

"VALLEIRON"
NITRIC ACID RETORTS, CASCADES, PANS, ETC.
NITRATORS.
FUSION KETTLES.
REDUCERS. ACID EGGS.
SULPHONATORS.
AUTOCLAVES.
CAUSTIC POTS. ETC.
MIXING KETTLE
AUTOCLAVE
SULPHONATOR
We Design & Manufacture "High Grade" Chemical Machinery
NEW YORK OFFICE 30 CHURCH ST.
VALLEY IRON WORKS
WILLIAMSPORT, PA.
U.S.A.



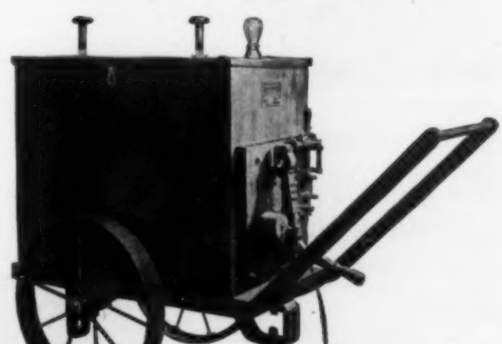




Coil Testing Outfit, with Wattmeter



Portable Carriage Type Insulation Testing Outfit

On your next Chemical Order—

Specify

"BAKER'S Analyzed"

Chemicals & Acids

After a trial you will specify them on ALL your orders, because you will find them dependable reagents of the highest quality and uniformity.

An Accurate Analysis Appears on the Label of Each Bottle.

Catalogue on Request

J. T. Baker Chemical Co.

Phillipsburg, N. J.

For Safety and Comfort

The HAYWARD Respirator

Hayward Respirator

With this device the user is completely protected against poisonous dust, fumes or smoke—a double filtering improvement makes this a certainty.

THE HAYWARD is, moreover, a comfortable respirator—there is nothing about it to annoy or cause any inconvenience. All metal parts are constructed of aluminum—and there is a soft pneumatic rubber face cushion which makes a very easy but absolutely air-tight contact between the body of the respirator and the wearer.

Light, simple and strong in design.

Write for Safety Catalog

AMERICAN-LAFRANCE FIRE ENGINE COMPANY, INC.

Elmira, N. Y.

Atlanta, Baltimore, Boston, Chicago, Dallas, Denver, Los Angeles, Minneapolis, San Francisco, New York, Philadelphia, Pittsburgh, Portland, Ore.

Toronto, Ontario, Canada.

Manufacturers of Safety Devices for every purpose.

Camp Shaking Machines

(Patented)

The model illustrated above, No. 6158, accommodating 12 Volumetric Flasks, 100 cc. capacity is extensively used in sugar laboratories. Price, **$40.00.**

Model No. 6156 accommodates 6 Flasks, from 6 to 24 ounces capacity, either Florence or Erlenmeyer shape. This model is particularly suited for the rapid precipitation of phosphorus by the molybdic methods and dissolving steels or pig iron for carbon combustion. Price, **$36.00.**

EIMER *and* AMEND

Founded 1851

Industrial and Educational Laboratory Apparatus—Chemicals and Drugs

New York, N. Y. Pittsburgh, Pa. Ottawa, Canada

Made in Our Own Shop

CHEMICAL THERMOMETERS

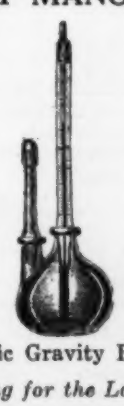
very accurately graduated on stem, of high grade quality, regular length

Graduated up to	110°	150°	200°	250°	300°	360° C
Price per dozen	$10.—	$11.—	$12.—	$13.—	$14.—	$14.50
Graduated up to			212°	300°	400°	600° F
Price per dozen			$10.—	$11.—	$12.—	$14.—

Special Thermometers and Hydrometers made to order.

Beckmann Thermometers

MERCURY MANOMETERS



- Balances
- Chemicals
- Reagents
- Indicators
- Test papers
- Filter paper
- Hot Plates (Gas and Electric)
- Drying ovens
- Burners
- Water stills
- Sidio ware
- Porcelain ware
- Rubber tubing

Specific Gravity Bottles

Everything for the Laboratory.

Lenz Apparatus Company, Inc.

9-11 East 16th Street, New York, N. Y.

PROFESSIONAL DIRECTORY

CHEMICAL ENGINEERS METALLURGISTS ENGINEERS CHEMISTS LABORATORIES ETC.

W. G. ABBOTT, JR.
Research Engineer
Development of Inventions, Special Machinery and Industrial Processes
Laboratory, WILTON, N. H.

JOHN F. ABERNETHY
Lead Burning Lead Lined Tanks
Lead Work of every description
703 Myrtle Ave., BROOKLYN, N. Y.

J. W. Beckman H. E. Linden
Beckman & Linden Engineering Corporation
Chemists Engineers
Examinations and reports of properties and the development of hydroelectric projects together with adjacent raw materials. Financing and management of industrial enterprises. Research work undertaken.
Balboa Bldg., San Francisco, Cal.

BOOTH, GARRETT & BLAIR
Metallurgical Chemists
Established 1836
Analysis of special steels, ores and minerals. Water analysis, bacteriological and sanitary.
404-6 Locust St., PHILADELPHIA, PA.

BYRNES, TOWNSEND & BRICKENSTEIN
C. P. Townsend J. H. Brickenstein
Patent Lawyers
Experts in Electricity, Metallurgy Chemistry, Electrochemistry.
918 F Street, Rooms 58, 59, 60, 61
WASHINGTON, D. C.

Canadian Inspection and Testing Laboratories, Limited
Consulting and Analytical Chemists
Inspecting and Metallurgical Engineers
Branches: Toronto, Winnipeg, Edmonton, Vancouver, New Glasgow.
Head Office & Laboratories, Montreal, Can.

ELECTRICAL TESTING LABORATORIES
Tests
80th St. and East End Ave.,
NEW YORK, N. Y.

Electrolytic Oxy-Hydrogen Laboratories, Inc.
"ELECTROLABS"
Isaac H. Levin Technical Director
Oxy-Hydrogen Installations Equipment Research
Laboratories and Works: Beaver Power Bldg., Dayton, O.
15 William St., New York

FALKENBURG & LAUCKS
Chemists
Sampling and Analysis
Inspection
All materials at PACIFIC PORTS
W. U. Code, Seattle, Wash.

THE FITZGERALD LABORATORIES, INC.
F. A. J. FitzGerald, Pres.
NIAGARA FALLS, N. Y.
Electric furnace processes and inventions—Expert advice regarding design and construction of commercial plants, heat insulation and refractories.

THE FRASER LABORATORIES
Analytical Dept., Fraser & Co.
Industrial Analytical Chemists
Ores, non-ferrous alloys, ferro-alloys, steels and metallurgical products analyzed.
Chemists' Building, 50 East 41st Street
New York City

EDWARD H. FRENCH & CO.
Consulting Chemical Engineers
Plant design, Construction and Improvement. Process investigation. Experienced in refining organic Chemicals. Coal tar products, wood distillation, acetic acid, acetone, turpentines, petroleum, bromine, pigments, insecticides, flotation oils.
606 Brunson Bldg., COLUMBUS, OHIO

GEIJSBEEK ENGINEERING CO.
Consulting Industrial and Chemical Engineers
Factory and Mill designing and construction. Drying, Heating and Evaporating Engineering. Efficiency and Cost Engineering. General Designing, Surveys and Maps. Testing Laboratories, Minerals, Ores.
Blake McFall Bldg., PORTLAND, ORE.

CLAUD S. GORDON COMPANY
Furnace and Pyrometer Engineers
Our Line:
Furnaces—Pyrometers—Boiler House Instruments
Our Specialties:
Furnace and Pyrometer Engineering, maintenance and inspection.
646 E. 75th St., CHICAGO

JAMES H. GRIFFIN, B.S., LL.M.
Patent Lawyer
277 Broadway, NEW YORK
Late Principal Examiner U. S. Patent Office. Member of the Bar of the U. S. Supreme Court. Specialist in Chemical, Electro-Chemical and Metallurgical Cases.
Reference, Eimer & Amend, N. Y.

N. L. HEINZ
Consulting Engineer
Metallurgy of Zinc and Manufacture of Sulphuric Acid.
1519 Oliver Bldg., PITTSBURGH, PA.

HERCULES ENGINEERING CORPORATION
Complete Chemical and Electrochemical Plants
Reports, Plans, Specifications and Purchasing
501 Fifth Avenue, NEW YORK CITY

CARL HERING
Consulting Electrical Engineer
Tests, Examinations, Researches, Reports Patent Litigation, Etc.
Electrical Furnaces, Thermal Engineering, Electrolytic Corrosion, Electro-Chemistry
210 S. 13th Street, PHILA., PA.

MILTON HERSEY CO., LTD.
Industrial Chemists, Inspectors and Engineers
Analytical and Assay Work. Steel Asphalt, Cement Tests. Research and Process Development. Prompt and Accurate Service.
NEW YORK 198 Broadway
MONTREAL 84 St. Antoine St.
WINNIPEG, 257 Portage Ave.

Robert W. Hunt Jno. J. Cone Jas. C. Hallsted D. W. McNaugher
ROBERT W. HUNT & CO.
Engineers Chemists
Metallurgists Inspectors
Examinations, Reports on Properties and Processes
2200 Insurance Exchange—CHICAGO

THE INSTITUTE OF INDUSTRIAL RESEARCH
WASHINGTON, D. C.
Divisions of Metallurgy, Paint Technology, Food and Drug Products, Roads and Pavements, Chemical Engineering.
Processes developed—
Designs, specifications and superintendence —Tests of materials of construction.

DR. CHARLES F. McKENNA
Consulting Chemist and Chemical Engineer
Expert in Technology and Testing of Materials
50 Church St., NEW YORK CITY

OTTO MANTIUS
Consulting Engineer
Chemical Plants
Evaporators, Causticizers
Chemical Machinery
Woolworth Bldg. NEW YORK CITY

CLARENCE W. MARSH
Consulting and Chemical Engineer
Personal constructive engineering service for investigation, organization, design and operation in the chemical industry.
Engineering Designer of the Largest Electrolytic Alkali Plant in the World.
101 Park Ave., NEW YORK, N. Y.

RICHARD K. MEADE & CO.
Chemical and Industrial Engineers
Chemical Plants Designed, Constructed, Reorganized and Operated.
Processes Investigated.
Law Building, BALTIMORE, MD.

Analyses Technical Reports Research
BERNARD ORMONT
Chemical Engineer
Design, investigation and development of mines and chemical plants and processes.
Patents Chemical-legal advice
Office and laboratory
104-106 John St., NEW YORK CITY
Phone John 2396

C. L. PARKER
Ex-Examiner Chemistry
U. S. Patent Office
Attorney-at-Law and Solicitor of Patents
McGill Bldg., WASHINGTON, D. C.

PROFESSIONAL DIRECTORY

CHEMICAL ENGINEERS METALLURGISTS ENGINEERS CHEMISTS LABORATORIES ETC.

FRANCIS J. PECK & CO.
Consulting Chemical Engineers
Chemical Plants designed, constructed investigated, reorganized, and operated Processes devised, developed and improved
Williamson Bldg.
CLEVELAND, OHIO

SAM'L P. SADTLER & SON
Consulting and Research Chemists
Report on chemical and electrochemical processes. Analyze Industrial and Technical Products.
Office and Laboratory
210 S. 13th St., PHILADELPHIA, PA.
Research Laboratory:
CHESTNUT HILL, PA.

CHAS. L. WEIL
Specializing in Evaporation and Utilization of Waste Vapor.
Consultation at Detroit by Appointment.
Mail Box 293. Phone 615-J.
PORT HURON, MICH.

EDWIN G. PIERCE
Consulting Chemist
Analysis, Testing Materials, Heat Treatment, Metallography
916 Kresge Bldg., DETROIT, MICH.
Youngstown, O. Alma, Mich.

Philip A. Singer Harris Perlstein
SINGER-PERLSTEIN CO.
Chemical and Industrial Engineers
Consultation. Reports. Specializing in Design, Erection, Operation and Improvement of Factories for Manufacture of Starch, Dextrin, Glucose, Malt, Maltose, Alcohol, Feed, Cereal Food and Oil, Cereal Milling.
Railway Exch., MILWAUKEE, WIS.

WERBY LABORATORIES
Chemists Analysts
Investigations, Recommendations and Reports made in all branches of Industrial Chemistry. Analyses and Inspection of Waste Products and Raw Materials. Chemical and Bacteriological Examinations of Foods, Drugs, etc. Special Rates on Contract Service.
29 Central Street, BOSTON, MASS.

PITTSBURGH TESTING LABORATORY
Research, Physical, Analytical and Bacteriological Laboratories
Design of Water Purification Plants
PITTSBURGH, PA.
James Otis Handy, Director of Laboratories.
Howard H. Craver, Chief Chemist

H. O. SWOBODA
Consulting Electrical Engineer
Investigation and Design of Special Electric Heaters and Furnaces Electric Power Plants
Empire Building Pittsburgh, Pa.

THE WILL CORPORATION
Industrial and Chemical Engineers
A conservative organization applying science with persistent energy to a practical solution of industrial problems.
Testing Laboratories
262 East Ave., ROCHESTER, N. Y.

RICKETTS & COMPANY, INC.
Mining, Metallurgical and Chemical Engineers
Mines and properties examined—Advice as to development and operation—Ore treatment methods determined. Assays and analyses of all materials and products—Complete laboratories for research work.
80 Maiden Lane NEW YORK

JOHN E. TEEPLE, PH.D.
Consulting Chemist, Chemical Engineer
Design of Chemical Plants, Investigation of Chemical Plants, Processes and Propositions.
50 East 41st St., NEW YORK

HAMLIN & MORRISON
Analytical Chemists
Established 1892
Forest Bldg., PHILADELPHIA, PA.

KENNETH DESPRES KAHN
S. B. Mass. Inst. Tech.
Chemical Engineer
1476 East 114th St., Cleveland, O.

ROOT & SIMPSON
successors to
LEONARD & ROOT
Assayers & Metallurgical Chemists
1744 Broadway, Denver, Colo.

LUDWIG A. THIELE, PH. D.
Chemical Engineer
Design and Construction of Chemical Plants.
Sulphuric Acid Plants (Tangent System), Fertilizer Plants, Extraction Plants (volatile solvents) } A Specialty
Supervision; Investigation of Plants. Processes and Propositions.
Hartman Building, COLUMBUS, OHIO

THE PROFESSIONAL DIRECTORY
gives you maximum results at a minimum cost. Write for particulars.

PROFESSIONAL MEN LISTEN

You can reach 11,300 *interested* readers of this journal by advertising in the Professional Directory.
1 inch card $1.00 an issue—$24 yearly; ½ inch card $ .50 an issue—$12 yearly.
And a copy of the paper free while you advertise.

Write us.

Metallurgical & Chemical Engineering
10th Avenue and 36th Street, New York

ATTENTION ANALYSTS! SPECIMEN LABEL

SQUIBB'S REAGENTS

A new line added to our list of High Grade Chemicals

A TRIAL WILL CONVINCE

Send us your want list and we shall be pleased to quote prices

SQUIBB'S REAGENT
Sodium Carbonate Cryst.
$Na_2CO_3.10\ H_2O$

Contains:		In. cent.
Chloride as Cl	(100 Gm.)	0.0005
Sulphate as SO_3	(100 Gm.)	0.005
Nitrate	(10 Gm.)	none
Phosphate	(100 Gm.)	none
Ammonium Salt	(20 Gm.)	none
Calcium	(100 Gm.)	none
Magnesium as MgO	(100 Gm.)	0.0013
Aluminum as Al_2O_3	(100 Gm.)	0.0001
Silicate	(20 Gm.)	none
Iron as Fe	(colorimetric)	0.0004
Sodium Hydroxide	(20 Gm.)	none
Loss at 120°C		62.20

The figures in parentheses express the quantities taken for each estimation.
LOT 15267

E. R. SQUIBB & SONS
Manufacturing Chemists, NEW YORK

SEARCHLIGHT SECTION

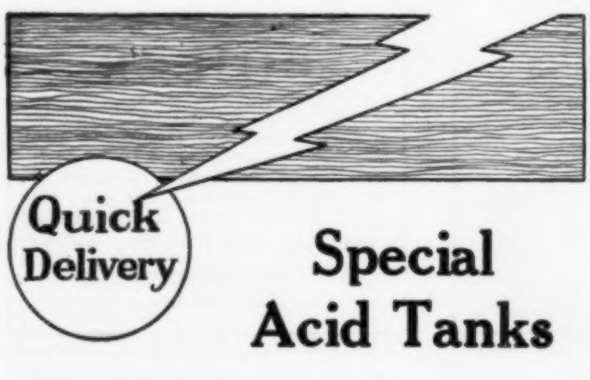
IDLE EQUIPMENT

Some of the following items have never been used, others only slightly, and in every instance each piece has been inspected and is ready for use.
To points near New York, use a motor truck, thereby relieving the railroads and express companies, as well as insuring prompt deliveries and saving on expense. We pride ourselves on satisfied customers, both purchasers and sellers. Try our service.

4—sheet steel steam jacketed kettles, 54" I.D. x 58" high, with cover and agitator.
12—110-gal. steel stills, 1" coil, agitator and reflux condenser.
2—110-gal. steel stills.
1—sheet steel still, 5' D. x 4' high with 2" coil.
10—sheet steel tanks, 3'6" x 4', cover and agitator.
1—sheet steel tank, ½" plate, 4' x 5', cover and agitator.
1—sheet steel filter tank, 4' x 5', either vacuum or pressure filtration or both.
1—sheet steel lead-lined tank, 4'6" x 4'6".
1—sheet steel tank, ½" plate, dished heads, 4' D. x 5'.
1—sheet steel lead-lined kettle, 6' x 5', bottom discharge.
2—sheet steel pressure or vacuum tanks, 2" D. x 9' long, 1 ¾" and 1 ½" opening.
1—sheet steel kettle, 3' x 4', with 4" bottom outlet.
1—sheet steel jacketed kettle, 4' D. x 3' high, no openings, ½" steam inlets and outlets.
1—sheet steel jacketed kettle, 30" D. x 4' 4" high, with agitator.
1—sheet steel jacketed tank, 54" x 24'.
2—automatic pulverizers, tubular dust collector, cyclone collector, etc., complete.
1—Acetone fractionating column, 14" sq., 15' high, 20 plates; coil condenser.
1—Swenson No. 1 Evaporator, with vacuum pump, etc., complete.
1—Badger-Webre copper triplet effect evaporator, 46" D. x 10' high, with all auxiliaries.
1—Swenson Triple Effect Evaporator, with auxiliaries.
2—oxygen gas compressors, vertical, two-stage brass-lined cylinders.
2—Deane duplex vacuum pumps, 20" x 18, acid bronze cylinders, piston and valve.
1—American, 10" x 14" x 20" wet vacuum pump, with jet condenser.
2—Chalmer & Williams No. 5 gyratory crushers.
1—Sturtevant, 5 x 10" jaw crusher.
2—Griffin mills, 30".
1—Universal Williams No. 3 crusher.
1—Universal Williams No. 0 crusher pulverizer.
1—Day Disintegrator.
1—Holmes & Blanchard 20" Disintegrator.
1—Ross No. 67 Disintegrator.
1—Ross crusher, 50 bus. per hr.
1—Schultz O'Neil, 28" pulverizer.
1—Jeffrey No. 605 pulverizer.
9—rotary kilns, 6' x 60'.
1—rotary kiln, 6' x 100'.
2—indirect heat dryers, 4' x 40'.
2—direct heat dryers, 5' x 60'.

Write for additional list of autoclaves, digestors, nitrators, reducers, sulphonators, stills and other chemical equipment, as well as of ice and refrigerating apparatus, gas and oil engines, gas producers, boilers and other power equipment. Your requirements given prompt and intelligent attention.

MACHINERY UTILITIES CO., 501 Fifth Avenue, New York City



Special Acid Tanks

7'-0" Dia., 5'-6" high open top, 7/16" side and bottom.

8'-0" Dia., 3'-0" high open top, 5/16" side and ⅜" bottom.

6'-6" Dia., 5'-0" high open top, 7/16" side and bottom.

4'-0" Dia., 6'-8" high open top, ½" side and bottom.

Strongly constructed. Low freight rate. Immediately available.

Tennessee Copper Co.
61 Broadway, New York City

Sulphur Burners

If you are planning to change over to sulphur burning, we can save you money on burners.

We have on hand at Copperhill, Tenn., for immediate delivery *new* Vesuvius Sulphur Burners.

On account of change in plans these were never installed.

Will sacrifice to prompt buyer. This is an opportunity.

Tennessee Copper Co.
61 Broadway, New York City

SEARCHLIGHT SECTION

PEBBLE MILLS

FOR SALE

5—6′ x 7′ Flint Lined Pebble Mills.
5—5′ x 6′ Flint Lined Pebble Mills.

National Products Company,
East Liverpool, Ohio

Silico-Manganese

A New Manganese Alloy

PACIFIC ELECTRO METALS COMPANY
Manufacturers of the best grade carbon electrodes

Address:
BECKMAN & LINDEN ENGINEERING CORP.
Balboa Building, San Francisco, Calif.

FOR SALE

2—250 H.P. each

Scotch Marine Boilers

Internally fired, good for 130 lbs. pressure. One Steel Stack, 58″ diameter; all used only a short time.

CARL M. GOTTFRIED
337 Alexander Street, Chicago, Ill.

500 K. W. Turbine

500 K.W. Capacity Westinghouse-Parsons Horizontal condensing Turbo-Alternator Unit, 60 Cycle, 2 Phase, 440 Volts, or 60 Cycle, 3 phase, 220 Volts. Surface Condenser can be furnished.

Advise your requirement for Power Apparatus. We can help you.

Paul Stewart & Company
Electrical and Steam Machinery
First National Bank Bldg. Cincinnati, Ohio

Acid Tank—

2500 ton, 50 ft. dia., 25 ft. high—with top. Extra heavy, triple riveted seams, complete with rivets.

Brand new—never erected

Send for our 32-page Bulletin No. 227, listing other tank bargains, etc.

ZELNICKER IN ST. LOUIS
Rails—Locomotives—Cars

FOR SALE

Open Tanks

9—15′ 6″ x 10′ x 4′ 6″ deep
5—23′ x 6′ 9″ x 4′ 6″ "
1—23′ x 3′ 6″ x 4′ 6″ "
1—10′ x 7′ 9″ x 4′ 6″ "
1—15′ 6″ x 7′ 9″ x 4′ 6″ "
8— 7′ 6″ x 7′ 6″ x 7′ "

These tanks are absolutely as good as new, made of wrought iron 5/16″ thick, are reinforced at top with heavy band, and inside by 1″ wrought iron rods, extending both ways.

STERLING IRON & STEEL CO.,
10th & Hamilton Sts., Philadelphia, Pa.

250 H.P. WICKES VERTICAL

BOILER

for immediate delivery, with full set of special brick and shapes and steel jacket for setting, also 4 ft. by 60 ft. steel stack. This boiler, designed for 200 pounds working pressure, was used only two months in experimental plant is fully equal to new. Address

PHOENIX REFINING CO.
Tulsa, Oklahoma

FOR SALE

OILS

17 Barrels Refined Corn Oil.
44 Barrels Palm Kernel Oil.
8 Barrels Palm Oil.
4 Barrels Poppyseed Oil.
8 Barrels Walnut Oil.
21 Barrels Rapeseed Oil.
On spot in New York

BOYER OIL COMPANY, Inc.
29 Broadway, New York City
Manufacturers and Specialists in Seed Oils

KETTLE

1—200 Gal. stationary steam-jacketed copper Kettle, 39″ diam. x 42″ deep. Same equipped with heavy frames, double brass stirrers and heavy side frames driven by beveled gears and fast and loose pulleys. 2½″ outlet in bottom. Outside copper body 5 pounds per square foot. Inside body 7½ pounds per square foot. Will sell without stirrers. This kettle is absolutely new, never having been used.

STERLING IRON & STEEL CO.,
10th & Hamilton Sts., Philadelphia, Pa.

Power Plant Machinery

Are you contemplating the installation of additional power plant machinery?
We offer, for immediate delivery:
6—300 H.P. Heine type BOILERS, 150 lbs. pressure.
6000 H.P. B. & W. Boilers, high pressure.
3—72″ x 18′ Return Tubular, high pressure.
Innumerable others.

Engines—Generators
Direct Connected Units
Alternating and Direct Current.
Complete Power Plants
Designed and Erected
Write for stock list.

POWER EQUIPMENT COMPANY, Engrs.
1218 Chestnut St., Philadelphia

Quantity of **USED TANKS** For Sale
4—6 ft. by 18 ft.
3—5 ft. by 16 ft.
3—5 ft. by 15 ft.
3—4½ ft. by 12 ft.
and a number of similar ones for sale cheap

BROOKLYN PAPER MILLS
96-98 Jay St., Brooklyn, N. Y.

Open Cast Iron Tanks for Sale

Seven 10′ x 6′ x 5′ 6″, metal ⅝″ and ⅞″ thick.
These tanks are reinforced by wrought iron rods extending both ways.

Sterling Iron & Steel Co.,
10th & Hamilton Sts., Philadelphia, Pa.

5 Sturtevant Blowers

with radiating coils for dry room or heating large building.
Also 4 steel tanks, 4 ft. diameter, 12 ft. long. For sale cheap.

BROOKLYN PAPER MILLS,
96 Jay St., Brooklyn, N. Y.

SEARCHLIGHT SECTION

FOR SALE

D. C. Generator

1 Holtzer-Cabot, 300 Amp., 50 volts, 15 K.W., 1150 R.P.M., 4 pole, Type C, shunt wound, complete with pulley, base and rheostat. Has been run only 10 hours. Price $350.

E. S. LINCOLN, INC.
534 Congress St., Portland, Maine

IMMEDIATE DELIVERY

We offer for immediate delivery, subject to prior sale, the following material, F.O.B. railroad shipping point Pittsburgh. Will sell as a whole or any item.

1—R. D. Wood Company Single Lift Gasholder; capacity 5000 cubic feet; diameter of holder 22′-3″ x 13′ deep. Built for ten pounds water pressure. (Unused, good condition)........$3000

1—Lummus Rectifying Still with full equipment consisting of one 1000 gallon still body, 6′ dia. x 6′ 3″ high; ¼″ plate; 5/16″ bottom. One extra 2500 gallon still body 7′ 6″ dia. x 8′ high, ¼″ plate. One 24″ column 18′ high with standard vaporizing hoods. One reflex condenser 9′ 5″ high, tubular type containing 110 square feet seamless tubing. (Unused, good condition) $3500

Synthetic Hydro-Carbon Company
331 Fourth Avenue, Pittsburgh, Pa.

FOR SALE

TWO

Williams Patent Crusher

and Pulverizer Co.'s No. 0 Universal

Fine Grinders

Each fitted with automatic feeder. Used less than two weeks and are absolutely good as new. Will sell for about two-thirds market price.

M. I. EVINGER
514 Farnam Bldg. Omaha, Neb.

Your Advancement

is largely in your own hands—it is doubtful if anyone else is worrying over it

Better positions are constantly being secured through small advertisements in the "Positions Wanted" Columns

60 cents for 20 words

FOR SALE

Quick Delivery

Reasonable Price

12 Steel Plate Tanks

20 ft. 0 in. long, 9 ft. 9 in. wide, 4 ft. 6 in. deep, metal 5/16 in. These tanks have never been used and can be shipped "knocked down" or riveted up.

TIPPETT & WOOD
Phillipsburg, N. J.

National Engineering Company

VIBRATING SEPARATORS

two 12 ft. and one 6 ft. in good condition, complete with pulleys and wire cloth.

UNITED STATES SILICA COMPANY,
419 Peoples Gas Building, Chicago, Illinois

WANTED

ELECTRIC FURNACE

New or second hand for the smelting of ferro-manganese ore, not exceeding 5 ton capacity, complete, with all electrical equipment, giving full details resale prices and delivery for export.

UNITED MACHINE WORKS
416 Bleecker St., New York City

FANS

FOR SALE

One Sturtevant

belt-driven, height 10 ft., width 42 inches, diameter of fan 72 inches.

One American

belt-driven, height 10 ft., width 37 inches, diameter of fan 65 inches. First-class condition. Equipped to run for inspection. Box 435, Woodbridge, N. J.

BOILERS

Immediate Delivery

2—600 H.P. B. & W. type steel header, code built, 200 lb. working pressure water tube boilers with superheaters and Rooney stokers.

3—550 H.P. Stirling Water Tube, 160 lb., code built boilers. Hand fired.

1—512 H.P. Stirling high pressure, code built Water Tube Boiler, 175 lb. allowance complete with Rooney stoker, 98′ stack and breeching.

1—350 H.P. B. & W. steel header, code built, water tube boiler, 155 lb. allowance complete with Rooney stoker, stack and all fittings.

2—260 H.P. B. & W. steel header, code built, 175 lb. allowance with chain grate stokers.

1—400 H.P. Heine, code built, 160 lb. boiler with Hawley down draft furnaces.

PAUL STEWART & CO.
Electrical and Steam Machinery
First National Bank Bldg., Cincinnati, Ohio

FOR SALE

Pebble Mill, 42″ x 21′.
500 Gallon Open Fusion Kettle.
300 Gallon Copper Jacket Kettle.
4—40″ Hydro Extractors, Bottom Discharge.
10 Gallon Vacuum Pan with Pump and Condenser.
Hoop Driving Machine.
Newago Separator.
5 Bbl. Dough Mixer.
3 Bbl. Mixer with Jacket.
85 H.P. Stirling Water-tube Boiler.
50 K.W., 3 Phase, 60 Cycle, 2300 Volts Generator connected to a Vertical Automatic Engine.
160 K.W., 3 Phase, 60 Cycle, 2300 Volts, connected to a Vertical Oil Engi[illegible]

George J. Adams, Consulting Engineer
39 South St., New York

FOR SALE

1—U. S. Bureau of Mines
FLASH TESTER
for oils flashing, 100-310 C.

1—Engler
VISCOSIMETER

3—Brown
PYROMETERS
with indicating and recording instruments registering from 1 to 2500 degrees F., complete with three leads 40′ long.

1—Gould's
TRIPLEX PUMP
1¼″ x 4″ to work against a pressure of 300 lbs.

The above were purchased for experimental purposes and were used only one month.

C. O. TERWILLIGER, Herkimer, N. Y.

A Paramount Duty of the Day

The Utilization of IDLE EQUIPMENT

Let Us Be the Medium

2—Kelley Filters, 40″ x 9′.
1—Kelley Laboratory Press.
1—Oliver Continuous Filter.
2—Sweetland Filter Presses, Nos. 6 and 7.
1—Shriver Filter Press, 18″ x 18″, 28—2″ cakes.
2—Shriver Presses, 36″ x 36″.
1—Niles Filter Press. 30—1½″ cakes.
1—225 H.P. Scotch Marine Boiler.
5—Stirling Water Tube Boilers. 250-285 H.P.
1—40″ Steel Basket Centrifugal.
2—26″ Copper Basket Centrifugals.
1—20″ Monel Basket Centrifugal.
2—3′ x 15′ Devine Rotary Dryers.
1—330 sq. ft. Devine Shelf Dryer.
1—70 sq. ft. Devine Shelf Dryer.
4—Kilns, 6′ x 60′ and 7′ x 100′.
1—Triple Effect Evaporator, Badger-Webre, all copper.
1—Triple Effect Copper Tubes.
1—125 gal. Enameled Still, condenser.
1—100 gal. Agitated Enameled Still.
1—75 gal. Agitated Enameled Still.
Storage Tanks, 3000, 4000, 15,000 gals.

MOTORS, ENGINES, MIXERS, TANKS, GRINDERS

CONSOLIDATED PRODUCTS COMPANY
15 Park Row, New York City **Barclay 8180**

Man Shortage?—No!

There are plenty of competent men reading the "Positions Vacant" and "Agents and Salesmen" ads in the Searchlight Section who would be glad to know of an opening in YOUR organization.

It costs only 5c a word, minimum $1.50 an insertion, to tell them.

WE BUY SCRAP PLATINUM

or any material containing Gold, Platinum or Iridium

WE PAY MARKET PRICES

Consignments held subject to your acceptance of our offer.

Goldsmith Bros. Smelting & Refining Co.

Chicago, Heyworth Bldg.
Seattle, Green Bldg.
New York, 20 John St.
Toronto, 24 Adelaide St., W.

SEARCHLIGHT SECTION

Get your Wants into the Searchlight

ADVERTISING RATES

Under "Positions Wanted," including Salesmen looking for new connections, Evening Work Wanted, etc., undisplayed advertisements cost **three cents a word,** minimum charge 50 cents an insertion, **payable in advance;** less 10% if one payment is made in advance for 4 continuous insertions.

Under "Positions Vacant," including Agents and Agencies Wanted, Representatives Wanted, Salesmen Wanted, Partners Wanted, Business Opportunities, Employment Agencies, and Miscellaneous For Sale, For Rent, and Want ads; also Auction Notices, Receivers' Sales, Machinery and Plants For Sale or Wanted, undisplayed advertisements set solid in one paragraph, cost **five cents a word,** minimum charge $1.50 an insertion.

Machinery advertisements (undisplayed) set with a paragraph for each item, or tabulated, 30 cents a line, minimum 5 lines.

If replies are in care of any of our offices, allow five words for the address.

Advertisements for bids (Proposals) $2.40 an in.

ADVERTISEMENTS IN DISPLAY TYPE

1/16 p. (1 1/8 x 3 3/8 ins.)	$5.00	1 in. (1 x 2 1/16 ins.)	$3.00
1/8 p. (2 3/8 x 3 3/8 ins.)	10.00	4 inches (4 x 2 1/16 ins.)	11.60
1/4 p. (5 x 3 3/8 or 2 3/8 x 7 ins.)	20.00	8 inches (8 x 2 1/16 ins.)	22.40
1/2 p. (10 1/4 x 3 3/8 or 5 x 7 ins.)	40.00	15 inches	40.50

For space to be used within one year, to be divided to suit requirements of advertiser, provided some space is used at least once a month following first insertion:

1 page	$80 a page	9 pages	$65 a page
3 pages	75 a page	12 pages	60 a page
6 pages	70 a page	18 pages	55 a page

In replying to advertisements, do NOT enclose original testimonials, or anything that you may want returned. State your qualifications in as concise and neat a manner as you can and enclose COPIES of testimonials. In machinery ads, use a local name or address if possible so that readers can wire direct and get quick replies.

FOR SALE

Vacuum Pump

For sale: 1 Dean wet vacuum pump, 8x12x12. E. P. Hovey, Security Mutual, Lincoln, Neb.

Vacuum Drum Dryers

For Sale—2 vacuum drum dryers, 2'x4' high pressure steel drums, including improved scraping knives in excellent condition; original cost $3,000 each. Will sell for $1,000 each. E. P. Hovey, 1301 N. St., Lincoln, Neb.

Centrifugal Pump for Sale

One 30" Weston centrifugal; belt driven, clutch pulley, countershaft, steel basket, 43' double 3" belt. FS1897, Met. & Chem. Eng.

Creosoting Cylinders for Sale

SUITABLE FOR
Creosoting processes,
Oil stills,
Pipe stills,
Storage, oil, gasoline, acid, water, etc.
Pressure purposes,
Conversion into tank cars.

Prices f.o.b. cars less than value of flat steel.

One cylinder, near Philadelphia, 48 feet long, 6 feet diameter, ½ inch steel, working pressure 160 pounds, capacity about 9500 gallons, $1,500.

One cylinder, in Alabama, same as above, $1,500.

One cylinder, in Pennsylvania, 67 feet long, 6 feet diameter, ½ inch steel working pressure 160 pounds, capacity about 13000 gallons, $2,000.

Three cylinders, in Indiana, each is 43 feet long, 5½ feet diameter, ½ inch steel, working pressure 160 pounds, capacity about 7300 gallons, each, $1,200.

Two cylinders, in Wisconsin, each is 68 ft. long, 6 ft. diameter, ½ inch steel, working pressure 160 pounds, capacity about 13,500 gallons, each $2,000.

One cylinder, in California, 65 feet long, 6 ft. 4 in. diameter, ½ inch steel, working pressure 160 pounds, capacity about 14,500 gallons, $2,250.

Each is equipped with heavy track for operation of cars inside. This can be removed or adjusted.

All are perfectly clean, never having contained any liquid.

Above prices are f.o.b. cars at shipping points and are less than the flat materials are worth.

All are in excellent condition.

Inspection is invited.

J. A. Parkinson, 1510 Commerce Building.

Bell Phone Main 4256, Kansas City, Mo.

Emery Mill for Sale

One 24" vertical Sturtevant Mill Company emery mill; extra set of new stones. FS1898, Met. & Chem. Eng.

FOR SALE

Volumes for Sale

Chemical News, V. 1 to date; Chemical Gazette, V. 1-17 (1842-59); Jl. Soc. of Chem. Industry, London, 1875-1916; The Analyst, London, 1899-1916. All bound, offers. Box 105, Merchants Station, St. Louis, Mo.

Alternator for Sale

One 200 KW., 125 volt, 3 phase, 60 cycle, 600 R.P.M., National Electric Co. belted type alternator, complete, with 6 KW. direct-connected exciter. This machine has been used very little and is in excellent condition. Can make immediate shipment. Address A. H. Labisky, Purchasing Agent, University of Wisconsin, Madison, Wis.

Coal Mine for Sale

Operators and manufacturers, own your own coal mine, furnish yourself coal. Have for sale fully equipped bituminous coal mine in Pennsylvania, mining and shipping daily, or can furnish any kind mine wanted. Address L. G. Rosenthal, 209 West 118th St., New York City.

Evaporator for Sale

Swenson horizontal tube triple effect evaporator, 700 gals. per hr. rating; 168, 1¼" x 10 ga. x 6' 0", iron tubes in each effect. Wet vacuum, condensation pumps and connecting piping. All in good condition. Wm. G. Abbott, Jr., Wilton, N. H.

Assay Office for Sale

Only assay office in smelter town. Business established twenty years. Net profit in one year greater than price asked. First class equipment, cheap coal, cheap electric power. Good opportunity for capable assayer and chemist. FS1935, Met. & Chem. Engrg.

MISCELLANEOUS WANTS

Wanted at Once

For immediate shipment any quantity of battery lead plates, sediment scrap copper and wire, brass and all other grades of scrap material. Write to us today for our prices. National Metal & Rubber Co., 31 India Wharf, Boston, Mass.

Laboratory Equipment Wanted

Wanted to purchase second-hand analytical laboratory equipment for usual mineral analysis. W1939, Met. & Chem. Engrg.

BUSINESS OPPORTUNITIES

Rotary Furnace Laboratory

Equipped especially for the study upon a commercial scale of furnace problems such as potash from feldspar, burning lime, nodulizing ores, oxidizing and desulphurizing ores and chemicals, etc. Equipment includes 2' x 20' rotary kiln. Open for limited engagement upon favorable terms. BO1832, Met. & Chem. Eng., Real Estate Trust Bldg., Philadelphia.

POSITIONS WANTED

ANALYTICAL and consulting chemist and chemical engineer in position to contract for inspection and testing of materials. Iron, steel, alloy steels, explosives, non-ferrous alloys, etc. Furnish own requirements. Pittsburgh district. PW1890, Met. & Chem. Eng., Philadelphia.

CHEMICAL engineer, graduate, wide general experience in research, metallurgical, manufacturing, physical, electrochemical lines, etc., organic and inorganic, many years chief chemist large laboratories. Only responsible, first-class position considered. Full particulars and references. PW1880 Met. & Chem. Eng., Chicago.

CHEMICAL and electrochemical engineer, technically trained and experienced in industrial chemical, chemical engineering, and electrochemical fields, electric furnaces and research. For five years director of electrochemical training and research in prominent institutions. Have held positions as chief chemist, chief metallurgist and director of research. Only high grade proposition considered. PW1889, Met. & Chem. Eng., Philadelphia.

CHEMICAL engineer, holding responsible position operating department large corporation. Wide experience handling of men, chemical manufacture, reduction of costs and accidents, plant operation. Will consider only position requiring ability, training, experience. PW1941, Met. & Chem. Engrg.

You Need
An Experienced Chemical
Executive.

I Believe I Am the Man You Want.

For complete information write PW1920, Met. & Chem. Eng., Leader News Bldg., Cleveland, O.

SEARCHLIGHT SECTION

Wanted: An Electrochemical Engineer

for an Exceptional Position

The MAN *we desire*

Must be a graduate of a first class technical university, preferably in chemical engineering, metallurgy or electrochemistry.

Must be resourceful and of an inventive turn of mind.

Should have had several years' experience in commercial research and development work.

Should be able to direct carefully and bring to definite conclusions experimental research work instigated and performed by others.

The DUTIES *of the position will involve*

(a) The supervision of a trained staff of technical men in the discovery and commercial development of new products and new uses for the company's present products.

(b) Consultation in connection with the technical phases of the company's current operations.

(c) Investigation and reporting on the practicability of new processes submitted to the company.

The employer is a successful, growing corporation, most of whose products are manufactured by electric furnace methods.

Salary will be commensurate with the experience and ability of the applicant. The position offers unusual opportunities for advancement to the man who can obtain results.

In replying tell the whole story of your qualifications and experience.

P1928, Metallurgical & Chemical Engineering, Hill Bldg., New York

POSITIONS WANTED

CHEMICAL engineer, graduate, married, an expert in the manufacture of phenol, thoroughly familiar with both construction and operation, in all their chemical and mechanical details, of plants employing sulphonations, neutralization, conversions, filtrations, evaporations, drying, caustic fusions, liberations, extractions, and distillations of various chemicals. Also experienced in the construction and operation of acid plants. Used to handling men. First class, responsible position desired. Good references. PW1932, Met. & Chem. Engrg.

CHEMICAL engineer, University graduate, thorough theoretical and practical knowledge of chemistry, organic and inorganic, analytical, physical, manufacturing; non-ferrous metallurgy (concentration and smelting), electro-chemistry, etc. Extensive and varied experience in both laboratory and large-scale operations, as executive and in handling men. Only high-grade position considered. PW1936, Met. & Chem. Engrg.

CHEMICAL engineer, at present holding responsible position in operating department of large corporation. Extensive experience in handling men and materials, combustion engineering, plant organization. Will consider only position of responsibility which will afford real opportunity to a man of ability, training and experience. PW1885, Met. & Chem. Eng.

METALLURGIST, CHEMIST

open for engagement after Jan. 1—25 years' experience—iron and steel, lead and copper smelting, cyaniding, lixiviation-superintendent, research man, head chemist. Now in charge of laboratories of large mining corporation. Three university degrees, exceptionally wide experience.

PW1947, Met. & Chem. Eng'g.

POSITIONS WANTED

CHEMIST, age 31, university training, several years' experience in the analysis of iron and steel. Employed at present but desires advancement. PW1716, Met. & Chem. Eng., N. Y. C.

CHIEF chemist and metallurgist, graduate, 10 years' chief chemist and metallurgist, zinc and sulphuric acid. Position desired as chemist-metallurgist or assistant superintendent. Salary, $2,400. PW1938, Met. & Chem. Engrg., Chicago.

ELECTROCHEMIST, graduate Mass. Inst. of Tech. 1915. Two years' experience in charge of chemical laboratory of large industrial concern. Thorough training in electro-chemistry, chemistry and electricity, desires position in New York City or vicinity. PW1882, Met. & Chem. Eng.

ELECTROMETALLURGICAL engineer, college graduate, wide experience in design and operating of electric steel furnaces, wants to connect with responsible firm. PW1810, Met. & Chem. Eng., Chicago.

EXECUTIVE position wanted. Technical graduate, diversified engineering experience. Expert stenographer. Brilliant correspondent. PW1942, Met. & Chem. Engrg.

Research or Manufacture

Electro metallurgical processes, ore concentration, Ferro alloys. Plant construction. Long and varied experience in chemical and electro chemical problems, including nitrogen fixation. PW1456, Met. & Chem. Eng., N. Y. C.

POSITIONS WANTED

GRADUATE metallurgical engineer with eight years' experience as metallurgist, electric furnace operator and superintendent, desires position. PW1857, Met. & Chem. Eng., Philadelphia.

PHARMACEUTICAL chemist, experienced manufacturer, keen and resourceful in developing new products, desires change. Have installed the manufacture of many successful products, such as alkaloids, active principles, pharmaceutical chemicals, synthetic and technical products. Desires connection with alert organization, in touch with raw materials and trade demands and willing to pay for results. PW1946, Met. & Chem. Engrg.

POSITION in general works laboratory of iron, steel and non-ferrous metal products company desired by experienced, University trained, energetic young metallurgical chemist. Direction of laboratory preferred. PW1940, Met. & Chem. Engrg.

SUPERINTENDENT of power or mechanical equipment—mechanical and electrical engineer of long experience in steam plant and electric power distribution engineering, desires responsible position on maintenance of factory equipment including installation. Exceptional references. PW1945, Met. & Chem. Engrg.

TECHNICAL executive, American, age 37, married, University graduate; 17 years' experience in chemical, metallurgical and electrochemical engineering as works manager and technologist. Desire to make a new connection, preferably on a salary and percentage of profit basis. Minimum salary considered $3,500 per year. PW1937, Met. & Chem. Eng., Philadelphia.

SEARCHLIGHT SECTION

POSITIONS VACANT

A large and growing process manufacturing company in a central Iowa city of 40,000 who are organizing an efficiency department require the services of several engineering graduates who want to connect with positions where ability, integrity and results are recognized. P1902, Met. & Chem. Eng., Chicago.

CHEMICAL laboratory assistant wanted in large laboratories in suburbs of New York. No war work. A steady position for the right man. Excellent chance for advancement because of rapid business increase. Application should state school, experience, age and salary last worked for and expected. P1815, Met. & Chem. Eng.

CHEMIST familiar with the extraction of vanadium for laboratories about 15 miles from New York City. No war work. Steady position for right man. Application should state school, experience, age and salary last worked for and expected. P1814, Met. & Chem. Eng.

CHEMIST, below draft age, wanted for general testing in laboratory of soap factory, good knowledge of analytical chemistry sufficient. Residence in vicinity of Philadelphia preferred. State salary desired. Address P. C. Tomson & Co., 27 Washington Ave., Philadelphia.

Excellent Position for

Competent Chemist

A nationally known manufacturer with a remarkable record for progress desires a competent chemist as manager of its Research Laboratories.

Paint and Varnish Experience Is Essential

In addition to being thoroughly grounded in Chemistry, the man desired will have had considerable experience in the manufacture of varnish. He will have charge of that part of our business as well as the research work.

The laboratory is well equipped and organized. The future of the business is unlimited. The present pay will be attractive but the ultimate remuneration should make this connection unusually worth while to the man with demonstrated ability.

If you have these qualifications we should be pleased to hear from you and your communication will be held in strictest confidence. We should like to know about your training, experience, age and salary expected.

Address P1930, Metallurgical & Chemical Engineering.

RATES:

1 inch—$3.00
4 inches—$2.90 an inch

(The above rate applies to a 4-inch space in one issue, a 2-inch space in two issues, or a 1-inch space in four issues. The larger spaces following may be used up in a similar way.)

8 inches—$2.80 an inch
15 inches— 2.70 an inch
27 inches— 2.60 an inch

POSITIONS VACANT

CHEMIST, experienced man for commercial work. Must be thoroughly experienced on steels and oils. Write, stating experience and salary expected. The Remington Arms Co., Boston Ave., Bridgeport, Conn.

CHEMISTS wanted in a large chemical plant. State education and training fully. Successful applicants will be required to work shift work at start. P1934, Met. & Chem. Engrg.

CHEMIST wanted—A graduate in organic chemistry to work in research laboratory and develop results in the plant. Line, dye-stuff and intermediates. Our plant is an old establishment, and we will consider only those who want a permanent position, with ambition for advancement. State age, experience and salary expected. Apply Althouse Chemical Company, Reading, Pa.

DRAFTSMAN familiar with chemical and by-product plant layouts, piping, etc., to go to city in eastern part of U. S. Apply Ford, Bacon & Davis, New York City.

DRAFTSMAN wanted at once with chemical and acid experience. Good opportunity for right man. State wages expected. Apply by letter to P1943, Met. & Chem. Engrg.

LEAD blast furnace metallurgist wanted by a well established smelting company. Give experience, references and salary expected. Must be competent to handle operation of a one-furnace plant. P1742, Met. & Chem. Eng., Chicago.

MANUFACTURING concern located near New York has opening for organic research chemist. Recent university graduate preferred. In reply state training, present and past positions, present salary, salary expected, age, and when available. P1944, Met. & Chem. Engrg.

Position Open

for experienced Chemist, capable of taking charge of the Laboratory at a By-product Coke Plant with Benzol Recovery. Location Cleveland District. Application should give full information, including salary desired.

Address P. V. 1865
Metallurgical & Chemical Engineering
10th Ave. at 36th St., New York.

POSITIONS VACANT

METALLURGICAL analyst wanted in research laboratory of large concern. Must be rapid, accurate, and neat. Able to assay immediately for all common metals. Give training, experience, and references. P1931, Met. & Chem. Engrg.

PRACTICAL shop metallurgist wanted, preferably with some experience in electric furnace operation in connection with steel castings and melting ferrous alloys. Reply giving detailed description of experience and salary expected and when available. P1933, Met. & Chem. Engrg.

EMPLOYMENT AGENCIES

Correspondence Service

The undersigned provides a confidential service designed to locate openings through correspondence, for men earning not less than $2,500 and up to $25,000; all lines. Not an employment agency but a constructive, initiative service, covering individual negotiations. Established 1910. Complete privacy assured; present connections in no way jeopardized. Send name and address only for explanatory details. R. W. Bixby, D1, Niagara Square, Buffalo, N. Y.

Chemists Seeking Suitable Positions
and
Employers Seeking Suitable Chemists
write Julian M. Blair, Secretary
The Chemists' Employment Bureau
Nashville, Tenn.
A successful bureau. Strictly confidential. No charge to employers. No initial expense to chemists.

To Manufacturers

We can furnish Plant Superintendents, Plant Foremen, Chemical Engineers, and Chemists on short notice.

Write or call

National Employment Exchange
30 Church Street New York City

Get your Wants into the Searchlight

WHAT AND WHERE TO BUY

Equipment, Apparatus and Supplies Used by the Chemical, Metallurgical and Allied Industries with Names of Manufacturers and Distributors

Acetylene in Cylinders
Prest-O-Lite Co.

Acid Concentration Apparatus
Chemical Construction Co.
Duriron Castings Co.
International Glass Co., The
Kalbperry Corp., The
Pratt Eng. & Machine Co.
Thermal Syndicate, Ltd., The

Acid Distillation Apparatus
Buffalo Foundry & Machine Co.
Fulton Foundry & Machine Co.
Pratt Eng. & Mach. Co.
Thermal Syndicate, Ltd., The

Acid Eggs, Cast Iron
Bethlehem Fdry. & Mach. Co.
Buffalo Fdry. & Mach. Co.
Devine Co., J. P.
Elyria Enameled Products Co.
Fulton Foundry Co.
Stearns-Roger Mfg. Co.
Stuart & Peterson Co.
U. S. Cast Iron Pipe & Fdry. Co.

Acid Eggs, Stoneware, Acid Proof
Knight, Maurice A.
Pratt Eng. & Mach. Co.
U. S. Stoneware Co.

Acid Resisting Glass Enameled Apparatus
See Enameled Apparatus, Acid Resisting

Acid, Sulphuric
New Jersey Zinc Company, The

Acid Ware
See Enameled Ware, Glassware, Porcelain, Silica and Stoneware

Agitating Machinery
Caldwell, W. E., Co.

Agitator Tanks, Wood
Caldwell, W. E., Co.
Pacific Tank & Pipe Co.
Redwood Manufacturers Company.
Schwarzwalder, J., & Sons, Inc.

Agitators
Caldwell, W. E., Co.
Dorr Co., The
General Filtration Co., Inc.
U. S. Stoneware Co.

Air Conditioning Apparatus
Braemer Air Conditioning Corp.
Carrier Engineering Corp.
Fleisher, W. L., & Co., Inc.
Spray Engineering Co.

Air Separators
See Separators, Air

Air Washers
American Blower Co.
Braemer Air Conditioning Corp.
Carrier Engineering Corporation

Alloys
See Ferro-Alloys

Alloys, Special
American Magnesium Corp.
Goldschmidt Thermit Co.
Lavino, E. J., & Co.
Norton Laboratories, Inc.

Aluminum
Electric Smelt. & Alum. Co.

Amines
Newport Chemical Works, Inc.

Analytical Apparatus
Ainsworth, Wm., & Son
Bausch & Lomb Opt. Co.
Braun Corporation, The
Braun-Knecht-Heinmann Co.
Buffalo Dental Mfg. Co.
Central Scientific Co.
Daigger, A., & Co.
Eimer & Amend
Hoskins Mfg. Co.
Laboratory Apparatus Co., Pittsburgh
Laboratory Supply Co.
Mine & Smelter Supply Co.
Sargent, E. H., & Co.
Scientific Materials Co.
Thomas Co., Arthur H.

Analyzers, Gas & Automatic
Uehling Instrument Co.
Williams Apparatus Company

Antimony
Crown Metal Co.

Asbestos Cloth, Yarn, Banding Tape and Fiber
Asbestos Protected Metal Co.

Ash Handling Machinery
Guarantee Construction Co.

Assayers
See Professional Directory, Pages 110-111

Autoclaves
Buffalo Foundry & Machine Co.
Devine, J. P., Co.
Ott, Geo. F., Co.
Stokes, F. J., Machine Co.
Valley Iron Works (Williamsport, Pa.)

Automatic Car Drive Systems
Pratt Eng. & Machine Co.

Automatic Scales
American Kron Scale Co.

Automatic Skip Hoist Controllers
Cutler-Hammer Mfg. Co.

Bakelite
General Bakelite Co.

Balances and Weights
Ainsworth, Wm., & Son
American Kron Scale Co.
Bausch & Lomb Opt. Co.
Braun Corporation, The.
Braun-Knecht-Heinmann Co.
Central Scientific Co.
Eimer & Amend.
Gaertner, Wm., & Co.
Laboratory Supply Co.
Lenz Apparatus Co.
Mine & Smelter Supply Co.
Schaar & Co.

Ball Mills
See Mills, Ball, Pebble, Tube

Barrel Racks, Steel
Economy Engineering Co.

Barrels, Steel, Bilge, Agitator & Open Head
Detroit Range Boiler Co.

Baskets, Dipping
Newark Wire Cloth Co.

Bauxite
Laclede-Christy Clay Products Co.
Lavino, E. J., & Co.

Belt Conveyors
Barber-Greene Company
Caldwell, H. W., & Son Co.
Link-Belt Company
Smith Engineering Works.
Stephens-Adamson Mfg. Co.
Webster Mfg. Co., The

Belts, Conveying & Elevating
Smith Engineering Works.

Bins, Steel and Concrete
Brown Hoisting Machinery Co.

Bleaching Powder
Electro-Bleaching Gas Co.

Blowers, Fan or Positive Pressure
Abbé Engineering Co.
Abbé, Paul O.
American Blower Co.
Beach-Russ Company
Buffalo Steam Pump Co.,
Clarage Fan Co.
Connersville Blower Co.
Nash Engineering Co.

Blowers, Flotation
Connersville Blower Co.
Nash Engineering Co.

Boilers, Water Tube
Vogt, Henry, Machine Co.

Bolting Cloths, Silk
Abbé Engineering Co.
Abbé, Paul O.

Books
McGraw-Hill Book Company
Wiley, John, & Sons

Brick, Acid Proof
Chemical Construction Co.
General Ceramics Co.
Harbison-Walker Refractories Co.
Knight, Maurice A.
Laclede-Christy Clay Products Co.
Milton Brick Co.
U. S. Stoneware Co.

Brick and Clay, Fire
Carborundum Co.
Celite Products Co.
Foote Mineral Co.
Harbison-Walker Refractories Co.
Laclede-Christy Clay Products Co.
Mine & Smelter Supply Co.

Brick, Carborundum
Carborundum Co.

Brick, Chrome
Harbison-Walker Refractories Co.

Brick Insulating
Armstrong Cork & Insulation Co.
Celite Products Co.

Brick, Silica
Harbison-Walker Refractories Co.
Laclede-Christy Clay Products Co.

Bronze, Titanium Aluminum
Titanium Alloy Mfg. Co., Inc.

Brushes, Carbon
National Carbon Co.

Buckets, Clamshell & Drag Line
Brown Hoisting Machinery Co.

Bucket Elevators
Caldwell, H. W., & Son Co.
Link-Belt Company
Stephens-Adamson Mfg. Co.
Webster Mfg. Co., The

Burners, Acetylene
Prest-O-Lite Co.

Burners, Gas and Oil
Braun Corporation, The
Braun-Knecht-Heinmann Co.
Mine & Smelter Supply Co.
Rockwell, W. S., Co.

Burners, Sulphur
Glens Falls Machine Co.
Pratt Eng. & Machine Co.
Valley Iron Wks. (Appleton, Wis.)

Calcium Carbide
Union Carbide Co.

Calculating Machines
Marchant Calculating Machine Co.

Calorimeters
Central Scientific Co.
Emerson Apparatus Co.
Gaertner, Wm., & Co.
Sargent, E. H., & Co.
Schaeffer & Budenberg Mfg. Co.
Thomas, Arthur H., Co.

Carbons, Battery
National Carbon Co.

Carbons, Resistance
National Carbon Co.

Cars, Industrial
Easton Car & Construction Co.

Cars, Mine and Ore
Easton Car & Construction Co.

Cascade Basins, Acid Proof
Duriron Castings Co.
Thermal Syndicate, Ltd., The

Casseroles
Guernsey Earthenware Co.
Herold China & Pottery Co.
Laboratory Supply Co., The

Castings, Acid Proof
Bethlehem Fdry. & Mach. Co.
Buffalo Fdry. & Mach. Co.
Duriron Castings Co.
Fulton Foundry & Machine Co.
Lunkenheimer Co., The
Pacific Foundry Co.
U. S. Cast Iron Pipe & Fdry. Co.

Castings, Bronze & Brass
Titanium Alloy Mfg. Co., The

Castings, Chemical
Bethlehem Fdry. & Mach. Co.
Buffalo Fdry. & Mach. Co.
Duriron Castings Co.
Jacoby, Henry E.
Lehigh Car Wheel & Axle Works
Lunkenheimer Co., The
Pacific Foundry Co.
Pratt Eng. & Mach. Co.
Sperry, D. R., & Co.
Valley Iron Works

Castings, Iron
American Cast Iron Pipe Co.
Cast Iron Pipe Publicity Bureau
Lunkenheimer Co., The

Castings, Lead
Craig Foundry Co.

Castings, Monel Metal
Supplee-Biddle Hdwe. Co.

Castings, Pure Copper
Titanium Alloy Mfg. Co., Inc.

Castings, Silicon
Carborundum Co.

Castings, Special & Chilled
Fulton Foundry & Machine Co.
U. S. Cast Iron Pipe & Fdry. Co.

Caustic Pots
See Pots, Cast Iron, Acid Proof

Caustic Soda and Chlorine Liquid
Electro-Bleaching Gas Co.

Caustic Soda and Chlorine
Electrolytic Cells for Making
Electro Chemical Co., The
Electrolytic Engineering Corp.
Electron Chemical Co.
Warner Chemical Co.

Causticizing Apparatus
Dorr Co., The
Scott, Ernest, & Co.
Zaremba Co.

Cement, Acid Proof
Anti-Hydro Waterproofing Co.

Cement, Furnace
Quigley Furnace Specialties Co.

Centrifuges
Schaum & Uhlinger, Inc.
Sharples Specialty Co.
Tolhurst Machine Works
Wayte, W. J., Inc.

Chain Doors
Codd, E. J., Co.

Chemical Apparatus
See Acid Eggs, Castings Chemical, Distilling Machinery and Apparatus, Drying Machinery and Apparatus, Enameled Apparatus, Evaporators, Filter Presses, Glassware, Separators Centrifugal, Stoneware, etc.

Chemical Engines
American La France Fire Engine Co.

Chemical Stoneware
See Stoneware, Chemical

Chemicals
Baker, J. T., Chem. Co.
Barrett Co., The
Braun Corporation, The
Braun-Knecht-Heinmann Co.
Daigger, A., & Co.
Eimer & Amend
General Chemical Co.
Heil, Henry Chemical Co.
Kauffman-Lattimer Co., The.
Laboratory Apparatus Co., Pittsburgh
Lenz Apparatus Co.
Marden, Orth & Hastings Corp.
Merck & Co.
Mine & Smelter Supply Co., The
Roessler & Hasslacher Chemical Co., The
Sargent, E. H., & Co.
Schaar & Co.
Scientific Materials Co.
Squibb, E. R., & Sons

Chemists, Manufacturing
Baker, J. T., Chem. Co.
Merck & Co.
Newport Chemical Works
Roessler & Hasslacher Chemical Co., The
Squibb, E. R., & Sons

Chemists and Chem. Engrs.
See Professional Directory, Pages 110-111

Chlorine, Liquid
See Caustic Soda and Chlorine

Classifiers
Colorado Iron Works Co.
Denver Engineering Works Co., The
Dorr Co., The
Worthington Pump & Mach. Corp.

Clay Goods
See Brick and Clay, also Porcelain Ware, also Stoneware, Chemical

Cloth, Carborundum and Aloxite
Carborundum Co.

Coal Tar Pitch
Barrett Co., The

Coal Tar Products
Newport Chemical Works, Inc.

Cocks, Cast Iron, Acid Proof
See Valves and Cocks, Cast Iron, Acid Proof

WHAT AND WHERE TO BUY

Cocks, Stoneware, Acid Proof
See Valves and Cocks, Stoneware, Acid Proof

Coils, Copper
Badger, E. B., & Sons Co.
Lummus The W. E. Co.
Roos, August, Son
Swenson Evaporator Co.
Werner & Pfleiderer Co.
Zaremba Co.

Coils & Worms, Stoneware
See Stoneware, Chemical

Combustion Boats
Engelhard, Chas.

Compressors, Air or Gas
Crowell Mfg. Co.
General Electric Co.
Nash Engineering Co.

Concentrating Tables
Mine & Smelter Supply Co., The

Concrete Hardening Compound (Liquid)
Anti-Hydro Waterproofing Co.

Condenser, Barometric, Surface or Jet
Buffalo Fdry. & Mach. Co.
Connersville Blower Co.
Devine Co., J. P.
Stokes, F. J., Machine Co.

Controllers, Temperature
Powers Regulator Co., The

Converters, Rotary
General Electric Co.
Lincoln Electric Co., The

Conveying Machinery
See Machinery, Elevating and Conveying

Conveyors, Portable
Barber-Greene Company

Coppersmithing
Badger, E. B., & Sons Co.
Lummus, The Walter E., Co.
Ott, George F., Co.
Roos', August, Son

Crane and Hoist Controllers
Cutler-Hammer Mfg. Co.

Cranes
Brown Hoisting Machinery Co.

Cranes, Locomotive
Link-Belt Company

Crucibles
Buffalo Dental Mfg. Co.
Duriron Castings Co.
Guernsey Earthenware Co.
Laboratory Supply Co.
Mine & Smelter Supply Co., The
Thermal Syndicate, Ltd., The

Crucibles, Clay
Denver Fire Clay Co.

Crucibles, Graphite
Acheson Graphite Co.
Bartley, Jonathan, Crucible Co.

Crushers, Grinders and Pulverizers
See Machinery, Crushing, Grinding and Pulverizing

Crushers, Grdrs., Pulv., Lab.
See Machinery, Crushing, Grinding and Pulverizing Laboratory

Crystallizing Dishes & Pans, Stoneware
See Stoneware, Chemical

Crystallizing Pans, Cast Iron
Buffalo Foundry & Machine Co.
Devine Co., J. P.
Pfaudler Company

Curb Boxes, Meter
American Cast Iron Pipe Co.
Cast Iron Pipe Publicity Bureau

Cyanide
Roessler & Hasslacher Chemical Co.

Cyanide Machinery
See Machinery, Cyanide

Cyanide Tanks
Caldwell, W. E., Co.

Diaphragms, Acid Proof
General Filtration Co., Inc.

Die Castings (Bronze)
Titanium Alloy Mfg. Co., Inc.

Diffusion Batteries
Blair, Campbell & McLean, Ltd.
Lummus, The W. E., Co.
Swenson Evaporator Co.

Digesters
Elyria Enameled Products Co.
Manitowoc Engineering Works
Stuart & Peterson Co.
Swenson Evaporator Co.
Werner & Pfleiderer Co.

Disintegrators
Stedman's Foundry & Machine Works

Distilling Machy. and Apparatus
Badger, E. B., & Sons Co.
Blair, Campbell & McLean, Ltd.
Carbondale Machine Co., The.
Detroit Heating & Lighting Co.
Devine Co., J. P.
Duriron Castings Co.
Elyria Enameled Products Co.
Fulton Foundry & Machine Co.
Isbell-Porter Co.
Koven, L. O., & Bro.
Lummus, The W. E., Co.
Ott, George F., Co.
Pfaudler Co., The
Roos', August, Son
Scott, Ernest, & Co.
Stevens-Alysworth Co.
Stokes, F. J., Machine Co.
Thomas Co., Arthur H.
Stuart & Peterson Co.
Swenson Evaporator Co.
Werner & Pfleiderer Co.
Zaremba Co.

Door Screens
Codd, E. J., Co.

Drop Forge Fittings
Vogt, Henry, Machine Co.

Drums, Steel
Detroit Range Boiler Co.

Dry Blast Plants
Carrier Engineering Corporation

Dry Cell Filler
Acheson Graphite Co.

Dryers, Centrifugal
Elmore, G. H.
Schaum & Uhlinger, Inc.
Sharples Specialty Co.
Tolhurst Mach. Works

Dryers, Vacuum
Buffalo Foundry & Machine Co.
Devine, J. P., Co.
Jacoby, Hy. E.
Scott, Ernest, & Co.
Sowers Mfg. Co.
Stokes, F. J., Machine Co.
Werner & Pfleiderer Co.

Drying Mach. & Apparatus
American Blower Co.
American Process Co.
Buffalo Foundry & Machine Co.
Buffalo Steam Pump Co.
Clarage Fan Co.
Denver Engineering Works Co., The
Devine Co., J. P.
Fleisher, W. L., & Co., Inc.
Gordon Engineering Corp.
Koven, L. O., & Bro.
Manitowoc Engineering Works
Ruggles-Coles Eng. Co.
Scott, Ernest, & Co.
Stearns-Roger Mfg. Co.
Stokes, F. J., Machine Co.
Swenson Evaporator Co.
Traylor Eng. & Mfg. Co.
Vulcan Iron Works
Werner & Pfleiderer Co.

Dust Collecting Systems & Engineers
Clark Dust Collecting Co.
Knickerbocker Co.
Pratt Eng. & Machine Co.
Raymond Bros. Imp. Pul. Co.
U. S. Blow Pipe & Dust Collecting Co.
Williams Patent Crusher & Pulverizer Co.

Dyes and Dyestuffs
Marden, Orth & Hastings Corp.

Dynamos, Electroplating
See Electroplating Dynamos, Supplies.

Dynamos and Motors
Bogue, C. J., Elect. Co.
General Electric Co.
Jantz & Leist Elect. Co.
Lincoln Electric Co.
Westinghouse Electric & Mfg. Co.

Electric Cranes
See Cranes

Electric Furnaces
See Furnaces, Electric

Electric Furnaces, Lab'y
See Furnaces, Elec. Lab'y.

Electrical Supplies
General Electric Co.

Electrical Testing Sets
American Transformer Co.
Weston Electrical Inst. Co.

Electrodes, Carbon
Acheson Graphite Co.
National Carbon Co.

Electrodes, Graphite
Acheson Graphite Co.
Beckman & Linden Eng. Corp.
Pacific Electro Metal Co.

Electrolytic Cells
Electro Chemical Company, The
Electrolytic Eng. Corp.
Electron Chemical Co.
Warner Chemical Co.

Electroplating Dynamos: Supplies
Bogue, C. J., Elect. Co.
Jantz & Leist Elect. Co.

Electrolytic Cells
Electrolytic Engineering Corp.

Electrolytic Salts
Roessler & Hasslacher Chem. Co.

Elevating and Conveying Machinery
See Machinery, Conveying and Elevating

Elevators, Portable
Economy Engineering Co.

Enameled Apparatus, Acid Resisting
Elyria Enameled Products Co.
Pfaudler Co., The
Stearns-Roger Mfg. Co.
Stuart & Peterson Co.

Engineers, Chemical, Consulting, Analytical, Industrial
Also see Professional Directory, 110-111
Fleisher, W. L., & Co., Inc.
Hercules Engineering Corporation
Kalbperry Corp., The
Little, Arthur D., Inc.
Powdered Coal Eng. & Equipment Co.
Pratt Eng. & Machine Co.
Research Laboratory of Chicago.
Southwestern Engineering Co.
Uehling Instrument Co.
Wayte, W. J., Inc.
Williams Apparatus Company

Engineers, Combustion
Improved Equipment Co.
Steere Eng. Co.
Uehling Instrument Co.

Engineers' Construction
Chemical Construction Co.
Foundation Co.
Green, Samuel M., Co.
Guarantee Construction Co.
Hercules Engineering Corporation
Southwestern Engineering Co.

Engineers, Furnace
Hagan, Geo. J., Co.
Industrial Electric Furnace Co.
Rockwell, W. S., Co.
Russell Engineering Company

Engineers, Pyrometric
Holz, Herman A.

Engines, Steam and Hauling
Denver Engineering Works Co., The
Sturtevant, B. F., Co.
Vulcan Iron Works

Equipment (2nd Hand)
See Searchlight Section, Pages 113 to 118

Evaporating Dishes
Guernsey Earthenware Co.
Knight, Maurice A.
Thermal Syndicate, Ltd., The
U. S. Stoneware Co.

Evaporators
Allbright-Nell Co., The
Badger, E. B., & Sons Co.
Blair, Campbell & McLean, Ltd.
Buffalo Fdry. & Mach. Co.
Devine, J. P., Co.
Jacoby, Henry E.
Kestner Evaporator Co.
Koven, L. O., & Bro.
Lummus, The W. E., Co.
Ott, Geo. F., Co.
Pfaudler Co., The
Pratt Eng. & Machine Co.
Roos', August, Son.
Scott, Ernest, & Co.
Sowers Manufacturing Co.
Sperry, D. R., & Sons
Stokes, F. J., Machine Co.
Swenson Evaporator Co.
Werner & Pfleiderer Co.
Zaremba Co.

Extracts
Marden, Orth & Hastings Corp.

Extractors
Badger, E. B., & Sons Co.
Blair, Campbell & McLean, Ltd.
Devine, J. P., Co.
Koven, L. O., & Bro.
Lummus, The W. E., Co.
Ott, Geo. F., Co.

Extractors, Centrifugal
Schaum & Uhlinger, Inc.
Sharples Specialty Co.
Tolhurst Machine Works

Fans
Buffalo Steam Pump Co.
Clarage Fan Co.
General Electric Co.
Pratt Eng. & Machine Co.
Raymond Bros. Impact Pulv. Co.
Stearns-Roger Mfg. Co.
Williams Patent Crusher & Pulv. Co.

Fans, Stoneware, Acid Proof
General Ceramics Co.
Knight, Maurice A.
U. S. Stoneware Co.

Faucets, Stoneware, Acid Proof
See Stoneware, Chemical

Feeders
Smith Engineering Works.
Stephens-Adamson Mfg. Co.
Webster M'f'g. Co., The

Ferro-Alloys
Continuous Reaction Co., The
Ferro-Alloy Co., The
Goldschmidt Thermit Co
Lavino, E. J., & Co.
Leavitt, C. W., & Co.
Standard Alloys Co.
Titanium Alloy Mfg. Co.

Ferro-carbon—Titanium
See Titanium

Ferro-Manganese
Beckman & Linden Eng. Corp.
Pacific Electro Metal Co.

Filter Cloth
Huyck, F. C., & Sons

Filter Cloth (Metallic)
Multi-Metal Separating Screen Co.
Newark Wire Cloth Co.
Supplee-Biddle Hardware Co.

Filter Paper
Angel, H. Reeve, & Co.
Carbondale Machine Co., The
Eimer & Amend
Laboratory Supply Co., The

Filter, Porous Porcelain
Herold China & Pottery Co.

Filter Presses
Allbright-Nell Co., The
Burger, Alfred, & Co.
Carbondale Machine Co., The.
Colorado Iron Works Co.
Industrial Filtration Corporation
Jacoby, Henry E.
Johnson, John Co.
Kelly Filter Press Co.
Koven, L. O., & Bro.
Lungwitz, E. E.
Oliver Continuous Filter Co.
Patterson Fdry. & Mach. Co.
Perrin, Wm. R., & Co.
Shriver, T., & Co.
Sperry, D. R., & Co.
United Filters Corpn.
Werner & Pfleiderer Co.

Filter Press Distill'y Grains
Swenson Evaporator Co.

Filtering Media
Celite Products Co.
General Filtration Co., Inc.

Filters, Laboratory
Perrin, Wm. R., & Co.

Filters, Rotary Continuous
Colorado Iron Works Co.
Industrial Filtration Corp.
Oliver Continuous Filter Co.
Southwestern Engineering Co.
United Filters Corpn.

Filters, Suction, Stoneware, Acid Proof
General Ceramics Co.
Knight, Maurice A.

Filters, Vacuum
General Filtration Co., Inc.
Stevens-Aylsworth Co.

Fire Brick and Clay
See Brick and Clay, Fire

Fire Extinguishers
American-La France Fire Engine Co.

Fire Sand, Carborundum
Carborundum Co.

Fireproof Building Materials
Asbestos Protected Metal Co.

Floors & Pits, Acid Resisting
Anti-Hydro Waterproofing Co.

Flotation Apparatus
Braun Corporation, The
Braun-Knecht-Heimann Co.
Colorado Iron Works
Denver Engineering Works Co., The
Pensacola Tar & Turpentine Co.
Southwestern Eng. Co.

Flotation Oil
Pensacola Tar & Turpentine Co.
Standard Chemical Co.

Fluorspar
Lavino, E. J., & Co.

Foundry Supplies
Electric Smelting & Alum. Co.

Furnace Cement
See Cement, Furnace

Furnace Engineers
See Engineers, Furnace

Furnace Facings & Linings
Acheson Graphite Co.
Celite Products Co.
Laclede-Christy Clay Products Co.
Quigley Furnace Specialties Co.

Furnace Hoists
Brown Hoisting Machinery Co.

Furnaces, Assay
Braun Corporation, The.
Braun-Knecht-Heimann Co.
Mine & Smelter Supply Co.

Furnaces, Chloridizing and Sulphating
Wedge Mechanical Furnace Co.

Furnaces, Cupola, Foundry
Worthington Pump & Mach. Corp.

Furnaces, Electric
Hamilton & Hansell, Inc.
Leavitt, C. W., & Co.

Furnaces, Electric, Lab'y.
Brown Instrument Co.
Central Scientific Co.
Electric Htg. Apparatus Co.
Engelhard, Chas.
Hoskins Mfg. Co.

Furnaces, Heat Treating
Electric Htg. Apparatus Co.
Engelhard, Chas.
Hagan Geo. J., Co.
Hoskins Mfg. Co.
Rockwell, W. S., Co.
Russell Engineering Co.
Wedge Mechanical Furnace Co.

Furnaces, Melting:
Oil, Gas or Powdered Coal
Hagan, Geo. J., Co.
Rockwell, W. S., Co.
Russell Engineering Company.

Furnaces, Muffle
Denver Fire Clay Co.
Electric Htg. Apparatus Co.
Hoskins Mfg. Co.
Improved Equipment Co.
Russell Engineering Company.
Wedge Mechanical Furnace Co.

Furnaces, Roasting and Smelting
Colorado Iron Works Co.
General Chemical Co., The.
Pacific Foundry Co.
Russell Engineering Company.
Traylor Eng. & Mfg. Co.
Wedge Mechanical Furnace Co.

Furnaces, Sulphur
General Chemical Co., The.
Pacific Foundry Co.
Pratt Eng. & Machine Co.
Schutte & Koerting Co.
Wedge Mechanical Furnace Co.

Fused Silica
Thermal Syndicate, Ltd., The.

Gas Furnaces
See Furnaces, Gas

Gas Producers
Chapman Eng. Co.
Flinn & Dreffein Co.
Hagan, Geo. J., Co.
Improved Equipment Co.
Morgan Const. Co.
Smith Gas Engineering Co., The

Gas Pumps and Exhausters
See Pumps, Gas, Liquid or Vacuum

Gas Scrubbers and Washers
Buffalo Steam Pump Co.

Gauges, Recording, Indicating, Draft, Pressure
Bristol Co., The.
Brown Instrument Co.
Foxboro Co.
Pneumercator Co., Inc.
Taylor Instrument Companies.
Thwing Instrument Co.
Uehling Instrument Co.

Gears
Caldwell, H. W., & Son Co.

Gears, Silent
General Electric Co.

Generators
See Dynamos and Motors

WHAT AND WHERE TO BUY

Glass Blowing
Central Scientific Co.
International Glass Co.
Kauffman-Lattimer Co., The.
Laboratory Supply Co.
Lenz Apparatus Co.
Scientific Materials Co.

Glassware, Chemical
Flasks, Beakers, Crystallizing Dishes, Hydrometer Jars, Petri Dishes, etc.
Central Scientific Co.
Eimer & Amend.
Fry Glass Co., H. C.
Griebel Instrument Co.
Heil, H., Chemical Co.
International Glass Co., The.
Laboratory Supply Co., The.
Mine & Smelter Supply Co., The.

Glazing Construction
Asbestos Protected Metal Co.

Graphite
Acheson Graphite Co.

Grinders
See Machinery, Crushing, Grinding and Pulverizing

Hardness Testers
Holz, Herman A.

Heaters, Feed Water
Braemer Air Conditioning Corp.

Heating Apparatus and Systems
American Blower Co.
Braemer Air Conditioning Co.
Buffalo Steam Pump Co.
Clarage Fan Co.
Powers Regulator Co., The
Ruggles-Coles Eng. Co.
Sarco Co., Inc.

Heating Regulators
Powers Regulator Co., The

Hoists
Brown Hoisting Machinery Co.
Denver Engineering Works Co., The

Hoisting Machinery, Special
Economy Engineering Co.

Hoists, Portable Platform
Economy Engineering Co.

Hydrogen Plants
Improved Equipment Co.

Hydrometers
Griebel Instrument Co.
Taylor Instrument Companies.

Hypochlorite Cells
Electro Chemical Co.

Impregnating Apparatus
Devine, J. P., Co.

Instruments, Electrical and Testing
Bristol Co., The.
Brown Instrument Co.
Central Scientific Co.
Eimer & Amend.
General Electric Co.
Hoskins Mfg. Co.
Pyroelectric Instrument Co.
Shore Instrument Co.
Stupakoff Laboratories.
Thwing Instrument Co.
Uehling Instrument Co.
Westinghouse Electric & Mfg. Co.

Insulating Material, Electric
Redmanol Chemical Products Co.

Insulating Material, Heat
Armstrong Cork & Insulation Co.
Celite Products Co.
Maryland Products Co.

Intermediates
Marden, Orth & Hastings Corp.
Newport Chemical Works, Inc.

Iron and Steel Corrugated
Asbestos Protected Metal Co.

Jigs
Denver Engineering Works Co., The
Worthington Pump & Mach. Corp.

Kettles, Cast Iron Acid Proof
Bethlehem Fdry. & Mach. Co.
Buffalo Fdry. & Machine Co.
Devine, J. P., Co.
Duriron Castings Co.
Fulton Fdry. & Machine Co.
Pacific Foundry Co.
Sowers Manufacturing Co.
Stevens-Aylsworth Company.
U. S. Cast Iron Pipe & Fdry. Co.
Werner & Pfleiderer Co.

Kettles, Enameled, Acid Proof
Elyria Enameled Products Co.
Pfaudler Co., The
Stuart & Peterson Co.

Kettles, Steam Jacketed
Buffalo Fdy. & Machine Co.
Day, The J. H., Co.
Detroit Heating & Lighting Co.
Devine Co., J. P.
Duriron Castings Co.
Elyria Enameled Products Co.
Koven, L. O., & Bro.
Ott, George P., Co.
Pfaudler Company, The
Pratt Eng. & Mach. Co.
Stevens-Aylsworth Co.
Stokes, F. J., Machine Co.
Stuart & Peterson Co.
Werner & Pfleiderer Co.

Kettles, Stoneware, Acid Proof
See Stoneware, Chemical

Kiln, Lime
Improved Equipment Co.
Vulcan Iron Works

Kiln, Rotary & Nodulizing
American Process Co.
Ruggles-Coles Eng. Co.
Traylor Eng. & Mfg. Co.
Vulcan Iron Works

Laboratories, Chemical and Physical
Lunkenheimer Co., The

Laboratory Apparatus and Supplies
Bausch & Lomb Opt. Co.
Braun Corporation, The
Braun-Knecht-Heimann Co.
Buffalo Dental Mfg. Co.
Central Scientific Co.
Daigger, A., & Co.
Denver Fire Clay Co.
Eimer & Amend
Emerson Apparatus Co.
Gaertner, Wm., & Co.
Guernsey Earthenware Co.
Heil, Henry, Chemical Co.
Hoskins Mfg. Co.
International Glass Co.
Kauffman-Lattimer Co., The.
Laboratory Apparatus Co., Pittsburgh.
Laboratory Supply Co., The
Lenz Apparatus Co.
Mine & Smelter Supply Co., The
Multi-Metal Separating Screen Co.
Pyroelectric Instrument Co.
Sargent, E. H., & Co.
Schaar & Co.
Scientific Materials Co.
Thomas Co., Arthur H.

Lamp, Arc & Incandescent, Tungsten
General Electric Co.
Holz, H. A.

Lead
Crown Metal Co.

Lead Burners
Moore & Simonson

Leaded Zinc Oxide
New Jersey Zinc Company, The

Lifting Magnets
Cutler-Hammer Mfg. Co.

Lifts, Air Jet
Bethlehem Fdy. & Mach. Co.
Schutte & Koerting Co.

Lithopone
New Jersey Zinc Company, The

Loaders, Bucket
Barber-Greene Company

Locomotive Cranes
Brown Hoisting Machinery Co.

Locomotives, Gasoline
Fate, The J. D., Co.

Locomotives, Industrial
Fate, J. D. Co.
General Electric Co.
Vulcan Iron Works

Machinery, Agitating
Day, The J. H., Co.
Dorr Co., The
Stokes, F. J., Machine Co.
Werner & Pfleiderer Co.

Machinery, Automatic Weighing
American Kron Scale Co.
Schaffer Eng. & Equipment Co.
Werner & Pfleiderer Co.

Machinery, Classifying
Denver Engineering Works Co., The
Dorr Co., The
Traylor Eng. & Mfg. Co.

Machinery, Coal Grinding
Aero Pulverizer Co.
Powdered Coal Eng. & Eqpt. Co.
Pratt Eng. & Machine Co.
Raymond Bros. Impt. Pulv. Co.
Williams Patent Crusher & Pulv. Co.

Machinery, Conveying & Elevating
Caldwell, H. W., & Son Co.
Guarantee Construction Co.
Link-Belt Company
Robins Conveying Belt Co.
Smith Engineering Works.
Stephens-Adamson Mfg. Co.
Webster Mfg. Co., The

Machinery, Crushing, Grinding and Pulverizing
Abbé Eng'g Co.
Abbé, Paul O.
Aero Pulverizer Co.
American Pulverizer Co.
Buchanan, C. G., & Co.
Colorado Iron Works Co.
Day, J. H. Co.
Denver Engineering Works Co., The
Denver Fire Clay Co.
Dunning, W. D.
Excelsior Tool & Machine Co.
Hardinge Conical Mill Co.
K-B Pulverizer Co.
Kent Mill Co.
Mead & Co.
Mine & Smelter Supply Co.
Patterson Fdy. & Mach. Co.
Pratt Eng. & Machine Co.
Raymond Bros. Imp. Pulv. Co.
Smith Engineering Works.
Stedman's Foundry & Mach. Works
Sturtevant Mill Co.
Traylor Eng. & Mfg. Co.
Vulcan Iron Works
Williams Patent Crusher & Pulverizer Co.
Worthington Pump & Machy. Corp.

Machinery, Crushing, Grinding & Pulverizing Lab'y
Abbé Eng'g Co.
Abbé, Paul O.
Braun Corporation, The
Braun-Knecht-Heimann Co.
Central Scientific Co.
Denver Engineering Works Co., The
Hardinge Conical Mill Co.
Sturtevant Mill Co.
Thomas Co., Arthur H.

Machinery, Cyanide
Colorado Iron Works Co.
Dorr Co., The
Traylor Eng. & Mfg. Co.
Worthington Pump & Machy. Corp.

Machinery, Electrical
General Electric Co.
Lincoln Electric Co., The

Machinery, Metallurgical and Mining
Abbé Eng'g Co.
Abbé, Paul O.
Aero Pulverizer Co.
American Process Co.
American Pulverizer Co.
Colorado Iron Works Co.
Denver Engineering Works Co., The
Dorr Co., The
Dwight & Lloyd Sintering Co.
Excelsior Tool & Machine Co.
General Chemical Co., The
Hardinge Conical Mill Co.
Huff Electrostatic Separator Co.
Kelly Filter Press Co.
Kent Mill Co.
Lungwitz, E. E.
Mine & Smelter Supply Co., The
Pacific Foundry Co.
Raymond Bros. Imp. Pulv. Co.
Ruggles-Coles Eng. Co.
Stearns-Roger Mfg. Co.
Sturtevant Mill Co.
Traylor Eng. & Mfg. Co.
United Filters Corpn.
Vulcan Iron Works
Wedge Mechanical Furnace Co.
Worthington Pump & Machy. Corp.

Machinery, Mixing and Kneading
Abbé Eng'g Co.
Abbé, Paul O.
Buffalo Fdy. & Machy. Co.
Day, J. H., Co.
Dunning, W. D.
Mead & Co.
Patterson Fdy. & Mach. Co.
Pratt Eng. & Machine Co.
Sowers Manufacturing Co.
Stokes, F. J., Machine Co.
Werner & Pfleiderer Co.
Worthington Pump & Machy. Corp.

Machinery, Ore and Coal Handling
Barber-Greene Company
Brown Hoisting Machinery Co.

Guarantee Construction Co.
Link-Belt Company
Smith Engineering Works.
Stephens-Adamson Mfg. Co.

Machinery, Ore Concentrating
Colorado Iron Works Co.
Denver Engineering Works Co., The
Dorr Co., The
Kent Mill Co.
Ruggles-Coles Eng. Co.
Mine and Smelter Supply Company
Traylor Eng. & Mfg. Co.
Worthington Pump & Machy. Corp.

Machinery, Refrigerating
Carbondale Machine Co., The.
Vogt, Henry Machine Co.

Machinery, Screening
Link-Belt Company
Stephens-Adamson Mfg. Co.
Traylor Eng. & Mfg. Co.
Smith Engineering Works.
Webster Mfg Co., The
Worthington Pump & Machy. Corp.

Machinery, Soap
Dunning, W. D.

Machinery, Special
Allbright-Nell Co., The
Buffalo Fdy & Machine Co.
Day, The J. H., Co.
Denver Engineering Works Co., The
Fulton Foundry & Machine Co.
Ruggles-Coles Eng. Co.
Stevens-Aylsworth Co.
Stokes, F. J., Machine Co.
Volta Mfg. Co., The
Werner & Pfleiderer Co.

Machinery, Thickening and Dewatering
Denver Engineering Works Co., The
Dorr, Co., The
Werner & Pfleiderer Co.

Machinery Transmission
Stephens-Adamson Mfg. Co.
Webster Mfg. Co., The

Machinery, Weighing
Schaeffer Eng. & Equipment Co.
Sturtevant Mill Co.
Werner & Pfleiderer Co.

Magnesite
Foote Mineral Co.
Harbison-Walker Refractories Co.

Magnetic Clutches
Cutler-Hammer Mfg. Co.

Magnetic Disc Brakes (Direct Current)
Cutler-Hammer Mfg. Co.

Magnesium Metal
American Magnesium Corp.
Leavitt, C. W., & Co.
Norton Laboratories, Inc.

Magnesium Ribbon
Dalgger, A., & Co.

Magnetic Pulleys
Dings Magnetic Separator Co.
Magnetic Mfg. Co.

Magnetic Separators
Buchanan Co., Inc., C. G.
Dings Magnetic Separator Co.
Magnetic Mfg. Co.

Magnets
Dings Magnetic Separator Co.

Magnets, Lifting
Cutler-Hammer Mfg. Co.

Metal, Asbestos Protected
Asbestos Protected Metal Co.

Metallographic Apparatus
Holz, Herman A.
Scientific Materials Co.

Metallo-Radiographic Apparatus
Holz, Herman A.

Metallurgical Clay Goods
Denver Fire Clay Co.

Metallurgical Engineers
See Professional Directory, Pages 110-111

Metallurgical Processes
Dorr Co., The
Dwight & Lloyd Sintering Co.

Metals
Electric Smelting & Alum. Co.
Ferro Alloy Co., The
Goldschmidt Thermit Co.
Lavino E. J., & Co.
Leavitt, C. W., & Co.
Metals Disintegrating Co.

Meter Box Covers
American Cast Iron Pipe Co.
Cast Iron Pipe Publicity Bureau

Meters, Flow, Air, Gas, Water
General Electric Co.
Spray Engineering Co.

Microscopes
Bausch & Lomb Opt. Co.
Central Scientific Co.
Scientific Materials Co.
Thomas Co., Arthur H.

WHAT AND WHERE TO BUY

Mills, Ball, Pebble and Tube
Abbé Eng'g Co.
Abbé, Paul O.
Colorado Iron Works Co.
Denver Engineering Works Co., The
Hardinge Conical Mill Co.
Mead & Co.
Mine & Smelter Supply Co., The
Patterson Fdy. & Mach. Co.
Stokes, F. J., Machine Co.
Traylor Eng. & Mfg. Co.

Mills, Conical
Hardinge Conical Mill Co.

Mills, Emery
Sturtevant Mill Co.

Minerals and Ores
American Magnesium Corp.
Continuous Reaction Co., The
Foote Mineral Co.
Lavino, E. J., & Co.
Leavitt, C. W., & Co.
Products Sales Co.
Vanadium Alloys Steel Co.

Mixers, Acidulating
Pratt Eng. & Mach. Co.

Mixers, Batch
Pratt Eng. & Mach. Co.
Smith Engineering Works.

Molybdenum Ore
Foote Mineral Co.

Monel Metal
Supplee-Biddle Hdwe. Co.

Montejus
See Acid Eggs, Cast Iron, also Stoneware

Motors, Electric
General Electric Co.
Lincoln Electric Co., The

Motor Speed Regulators
Cutler-Hammer Mfg. Co.

Motor Starters
Cutler-Hammer Mfg. Co.

Muffles
Mine & Smelter Supply Co., The
Russell Engineering Company

Nitro Compounds
Newport Chemical Works, Inc.

Nozzles, Spray
American Blower Co.
Buffalo Steam Pump Co.
Carrier Engineering Corporation
Duriron Castings Co.
Schutte & Koerting Co.
Spray Engineering Co.
Star Brass Works, The

Nozzles & Jets, Stoneware
See Stoneware, Chemical

Oils, Flotation
See Flotation Oil

Ore Bedding and Reclaiming Systems
Robins Conveying Belt Co.

Ores
See Minerals and Ores

Ovens, Laboratory
Central Scientific Co.

Oxide, Gas Purifying
Lavino, E. J., & Co.

Oxygen or Hydrogen Generating Equipment
International Oxygen Co.

Paint, Pigment, Graphite
Acheson Graphite Co.

Paints, Acid Proof and Technical
Toch Bros.

Pans, Vacuum
Badger, E. B., & Sons Co.
Blair, Campbell & McLean, Ltd.
Buffalo Fdy. & Mach. Co.
Detroit Heating & Lighting Co.
Devine J. P., Co.
Kestner Evaporator Co.
Koven, L. O., & Bro.
Lummus, The W. E., Co.
Pfaudler Company, The
Pratt Eng. & Machine Co.
Roos', August, Son
Scott, Ernest, & Co.
Sowers Manufacturing Co.
Stokes, F. J., Machine Co.
Swenson Evaporator Co.
Werner & Pfleiderer Co.
Zaremba Co.

Patent Attorneys
See Professional Directory, Pages 110-111

Pebble Mills
See Mills, Ball, Pebble and Tube

Perforated Metal
Mundt, Chas., & Sons

Photomicrographic Apparatus
Bausch & Lomb Opt. Co.

Pine Products
Pensacola Tar & Turpentine Co.
Standard Chemical Co.

Pipe, Cast Iron
American Cast Iron Pipe Co.
Cast Iron Pipe Publicity Bureau
Clow, James B. & Sons
Donaldson Iron Co.
Glamorgan Pipe & Foundry Co.
Lynchburg Foundry Co.
Massillon Iron & Steel Co.
U. S. Cast Iron Pipe & Fdy. Co.
Warren Foundry & Machine Co.

Pipe, Silica Ware
Thermal Syndicate, Ltd., The

Pipe, Silver
Wall Co., A. T.

Pipe & Fittings, Cast Iron, Acid Proof
Duriron Castings Co.
Lunkenheimer Co., The
Pacific Foundry Co.

Pipe & Fittings, Copper
Badger, E. B., & Sons Co.
Lummus, Walter E., Co., The
Ott, George F., Co.
Roos', August, Son

Pipe & Fittings, Enameled, Acid Proof
Elyria Enameled Products Co.
Pfaudler Co., The
Stuart & Peterson Co.

Pipe & Fittings, Lead, Tin or Silver Lined
Badger, E. B., & Sons Co.
Cleveland Brass Mfg. Co.
Lead Lined Iron Pipe Co.
Schutte & Koerting Co.
United Lined Tube & Valve Co.

Pipe & Fittings, Stoneware, Acid Proof
General Ceramics Co.
Graham C., Chem. Pottery Wks.
Knight, Maurice A.
U. S. Stoneware Co.

Pipe & Fittings, Wood
National Tank & Pipe Co.
Pacific Tank & Pipe Co.
Redwoods Manufacturers Company

Pitch, Coal Tar
Barrett Co., The

Plant Sites
Carolina, Clinchfield & Ohio R. R.

Platinum Wire, Sheet and Foil; Crucibles, Dishes, Electrodes, Laboratory Ware, all kinds.
American Platinum Works
Baker & Co., Inc.
Bishop, J., & Co., Platinum Wks.
Thomas Co., Arthur H.

Plug Cocks
See Valves and Cocks

Pneumercator
Pneumercator Co.

Porcelain Ware
Bausch & Lomb Opt. Co.
Braun Corporation, The
Braun-Knecht-Heimann Co.
Central Scientific Co.
Guernsey Earthenware Co.
Herold China & Pottery Co.
Laboratory Supply Co., The
Mine & Smelter Supply Co., The

Portable Conveyors
Barber-Greene Company

Pots, Cast Iron, Acid Proof
Bethlehem Foundry & Mach. Co.
Buffalo Foundry & Machine Co.
Duriron Castings Co.
Fulton Foundry & Machine Co.
Pratt Eng. & Mach. Co.
U. S. Cast Iron Pipe & Fdy. Co.
Werner & Pfleiderer Co.

Pots, Stoneware, Acid Proof
See Stoneware Chemical

Precipitants
Merrill Metallurgical Co.

Precipitators, Centrifugal
Schaum & Uhlinger, Inc.

Presses, Hydraulic
Perrin, Wm. R., & Co.

Producers, Gas
Steere Eng. Co.

Pulleys, Magnetic
Dings Magnetic Separator Co.

Pulverizers, Hammer Mill
K-B Pulverizer Co.

Pulverizers, Laboratory
See Machinery, Crushing, Grinding and Pulverizing, Laboratory

Pulverizing Machinery
See Machinery, Crushing, Grinding and Pulverizing

Pump Controllers
Cutler-Hammer Mfg. Co.

Pumps, Acid or Acid Gases
Abbé Eng'g Co.
Duriron Castings Co.
Elmore, G. H.
Nash Engineering Co.
Schutte & Koerting Co.
Worthington Pump & Mach'y Corp.

Pumps, Centrifugal
Abbé Eng'g Co.
Chemical Pump & Valve Co., The
Duriron Casting Co.
Elmore, G. H.
Wayte, W. J., Inc.
Worthington Pump & Mach'y Corp.

Pumps, Diaphragm
Wayte, W. J., Inc.

Pumps, Gas, Liq. or Vacuum
Abbé Eng'g Co.
Beach-Russ Company
Buffalo Fdy. & Mach. Co.
Central Scientific Co.
Connersville Blower Co.
Crowell Mfg. Co.
Devine, J. P., Co.
Nash Engineering Co., The
Pratt Eng. & Machine Co.
Worthington Pump & Mach'y Corp.

Pumps, Rotary, Oil or Water
Abbé Eng'g Co.
Connersville Blower Co.
Worthington Pump & Mach'y Corp.

Pumps, Sand
Krogh Pump Mfg. Co.
Traylor Eng. & Mfg. Co.

Pumps, Stoneware, Acid Proof
General Ceramics Co.
Knight, M. A.
U. S. Stoneware Co.

Pyrites
Lavino, E. J., & Co.

Pyrometers
Braun Corporation, The
Braun-Knecht-Heimann Co.
Bristol Co., The
Brown Instrument Co.
Central Scientific Co.
Engelhard, Chas.
Holz, Herman A.
Hoskins Mfg. Co.
Nehls, Carl, Alloy Co.
Pyrolectric Instrument Co.
Sargent, E. H., & Co.
Scientific Materials Co.
Shore Instrument Co.
Stupakoff Laboratories
Taylor Instrument Companies
Thomas Co., Arthur H.
Thwing Instrument Co.
Uehling Instrument Co.

Pyrometer Installations
Holz, Herman A.
Stupakoff Laboratories

Pyrometer Paste
Nehls, Carl, Alloy Co.

Pyrometer Protection Tubes
Engelhard, Chas.
Herold China & Pottery Co.
Stupakoff Laboratories
Thermal Syndicate, Ltd., The

Pyrometer Sheets, Graphite
Acheson Graphite Co.

Pyroscope
Shore Instrument Co.

Quartz Glass
See also Fused Silica
Engelhard, Chas.
Thermal Syndicate, Ltd., The

Racks, Steel Barrel Storage
Economy Eng. Co.

Railways, Industrial & Portable
Easton Car & Construction Co.

Recorders, CO_2
Uehling Instrument Co.

Recording Instruments, Pressure, Temperature, Electricity, Motion, Speed, Time
Bristol Co., The
Brown Instrument Co.
Engelhard, Chas.
Holz, Herman A.
Hoskins Mfg. Co.
Pyrolectric Instrument Co.
Taylor Instrument Companies
Thwing Instrument Co.
Uehling Instrument Co.

WHAT AND WHERE TO BUY

Refractories
See Brick and Clay, Fire

Refrigerating Machinery
See Machinery, Refrigerating

Regulators, Automatic Humidity
American Blower Co.
Carrier Engineering Corp.

Regulators, Pressure
Connersville Blower Co.
Steere Eng. Co.
Taylor Instrument Companies

Regulators, Temperature
Powers Regulator Co., The
Sarco Company, Inc.
Taylor Instrument Companies

Resistance Wire
See Wire, Resistance

Resistant Chemical Glassware
Fry, H. C., Glass Co.
International Glass Co., The

Respirators
American La France Fire Engine Co.

Retorts
See Acid Distillation Apparatus

Retorts, Graphite
Bartley, Jonathan, Cruc. Co.

Retorts, Vertical
Isbell-Porter Co.

Rheostats
Central Scientific Co.

Rolls, Crushing
Buchanan, C. G., Co., Inc.

Roofs, Walls, Partitions, etc., Concrete
Asbestos Protected Metal Co.

Roofings and Sidings—Fume Proof
Asbestos Protected Metal Co.
Brown Hoisting Machinery Co.

Safety Devices
American La France Fire Engine Co.

Safety Goggles
American La France Fire Engine Co.

Scales, Conveyor
American Kron Scale Co.
Schaffer Eng. & Equip. Co.

Scales, Weighing
American Kron Scale Co.
Sturtevant Mill Co.
Werner & Pfleiderer Co.

Scleroscope
Holz, Herman A.
Shore Instrument Co.

Screens
Colorado Iron Works Co.
Kent Mill Co.
Multi-Metal Separating Screen Co.
Mundt, Chas., & Co.
Newark Wire Cloth Co.
Patterson Fdy. & Mach. Co.
Smith Engineering Works.
Sturtevant Mill Co.
Worthington Pump & Machy. Corp.

Screens, Chain
Codd, E. J., Co.

Screen Doors
Codd, E. J., Co.

Screening Machinery
See Machinery, Screening

Separators, Air
Aero Pulverizer Co.
Pratt Eng. & Machine Co.
Raymond Bros. Imp. Pulv. Co.
Williams Patent Crusher & Pulverizer Co.

Separators, Centrifugal
Schaum & Uhlinger, Inc.
Sharples Specialty Co.
Tolhurst Mach. Wks.

Separators, Electrostatic
Huff Electrostatic Separator Co.

Separators, Magnetic
Buchanan, C. G., Co.
Cutler-Hammer Mfg. Co.
Dings Magnetic Separator Co.
Magnetic Mfg. Co.

Separators, Steam and Oil
Braemer Air Conditioning Corp.

Sieves, Laboratory
Newark Wire Cloth Co.

Silent Chain
Link-Belt Company

Silos, Wood
National Tank & Pipe Co.
Pacific Tank & Pipe Co.
Redwood Manufacturers Company

Silver Piping
See Pipe, Silver

Silver Rod, Sheet and Solder
Wall, A. T., Co.

Sintering Processes
Dwight & Lloyd Sintering Co.

Spelter, Spiegeleisen
New Jersey Zinc Company, The

Spray Nozzles
See Nozzles, Spray

Soldering & Brazing Outfits, Acetylene
Prest-O-Lite Company

Sprocket Wheels
Link-Belt Company

Steel, High Speed
Standard Alloys Co.

Stills, Chemical
See Distilling Machinery and Apparatus

Stirrers, Acid Proof
Acheson Graphite Co.
Duriron Castings Co.
Werner & Pfleiderer Co.

Stokers
Hagan, Geo. J., Co.
Laclede-Christy Clay Products Co.

Stoneware, Chemical, consisting of
Bottles, Carboy Stoppers, Coils and Worms, Crystallizing Dishes, Chlorine Generators, Decanting Pots, Dippers, Dipping Dishes, Faucets, Funnels, Kettles, Mortars and Pestles, Nozzles and Jets, Pots and Jars, Pitchers, Retorts, Receivers or Woulf Bottles, Sinks, Storage Jars, etc.
General Ceramics Co.
Graham, C., Chem. Pot'ry Wks.
Knight, Maurice A.
U. S. Stoneware Co.

Stopper Heads
Bartley, Jonathan, Crucible Co.

Sulphur Burners
See Burners, Sulphur

Sulphur, Crude
Union Sulphur Co., The

Sulphur Dioxide, Liquid
Ansul Chemical Co.

Sulphuric Acid Plants
Chemical Const. Co.
Kalbperry Corp., The

Switchboards
General Electric Co.
Westinghouse Electric & Mfg. Co.

Syphons, Acid, Stoneware
Knight, Maurice A.
U. S. Stoneware Co.

Syphons, Metal
Schutte & Koerting Co.

Tachometers
Foxboro Co.

Tanks, Cast Iron
Detroit Range Boiler Co.
Stevens-Aylsworth Co.

Tanks, Copper
Badger, E. B., & Sons Co.
Detroit Heating & Lighting Co.
Lummus, The W. E., Co.
Ott, George F., Co.
Roos' Son, August

Tanks, Cyanide
Acme Tank Co.
Pacific Tank & Pipe Co.
Redwood Manufacturers Company

Tanks, Enameled, Acid Proof
Elyria Enameled Products Co.
Pfaudler Co., The
Stuart & Peterson Co.

Tanks, Heating Regulators
Powers Regulator Co., The

Tanks, Lead Lined, Acid Proof
Acme Tank Co.
Blair, Campbell & McLean, Ltd.
Caldwell, W. E., Co.
Eagle Tank Co.
Hauser-Stander Tank Co.
United Lined Tube & Valve Co.

Tanks, Steel
Caldwell, W. E., Co.
Codd, E. J., Company
Detroit Range Boiler Co.
Hamburg Boiler Works
Kellogg, The M. W., Co.
Koven, L. O., & Bro.
Manitowoc Engineering Works
Prest-O-Lite Co.
Stevens-Alysworth Co.
Stevens Brothers

Tanks, Stoneware, Acid Proof
General Ceramics Co.
Graham, C., Chem. Pot'y Works
Knight, Maurice A.
U. S. Stoneware Co.

Tanks, Wood
Acme Tank Co.
Caldwell, W. E., Co.
Corcoran, A. J., Inc.
Eagle Tank Co.
Hauser-Stander Tank Co., The
Kalamazoo Tank & Silo Co.
National Tank & Pipe Co.
Pacific Tank & Pipe Co.
Redwood Manufacturers Company
Schwarzwalder, J., & Sons
U. S. Wind Engine & Pump Co.

Temperature Regulators
Taylor Instrument Companies

Testing Laboratories
See Professional Directory, Pages 110-111

Testing Machines, Metal
Holz, Herman A.
Shore Instrument Co.

Testing Sieves
Multi-Metal Separating Screen Co.

Thermit
Goldschmidt Thermit Co.

Thermocouples, Platinum
Holz, Herman A.

Thermometers
Bristol Co., The
Bausch & Lomb Opt. Co.
Central Scientific Co.
Engelhard, Chas.
Foxboro Co.
Gaertner, Wm., & Co.
Griebel Instrument Co.
Lenz Apparatus Co.
Pyrolectric Instrument Co.
Taylor Instrument Companies
Thwing Instrument Co.

Thermostats
Powers Regulator Co., The
Sarco Company, Inc.

Tiering Machines, Portable
Economy Engineering Co.

Tin
Crown Metal Co.

Titanium
Goldschmidt Thermit Co.
Titanium Alloy Mfg. Co.

Titanium Ores
Foote Mineral Co.
Titanium Alloy Mfg. Co.

Tool Steel
Standard Alloys Co.

Tower Packing, Acid Proof, Stoneware
Knight, Maurice A.
Laclede-Christy Clay Products Co.
U. S. Stoneware Co.

Towers, Acid
Duriron Castings Co.

Towers, Acid, Stoneware
General Ceramics Co.
Graham, C., Chem. Pot'y Wks.
Knight, Maurice A.
U. S. Stoneware Co.

Tracks, Industrial and Portable
Easton Car & Construction Co.

Transformers
American Transformer Co.
General Electric Co.
Kuhlman Electric Co., The
Westinghouse Electric & Mfg. Co.

Transformers, Special & Precipitation Process
American Transformer Co.
Kuhlman Electric Co., The

Transits
Ainsworth, Wm., & Son

Traps, Steam & Radiator
Sarco Company, Inc.

Trolleys, I Beam
Brown Hoisting Machinery Co.

Tube Mills
See Mills, Ball, Pebble, Tube

Tungsten Ores
Continuous Reaction Co., The
Vanadium-Alloys Steel Co.

Turntables, Industrial Railway
Easton Car & Construction Co.

Uranium Alloys
Standards Alloys Co.

Vacuum Drying Apparatus
See Dryers, Vacuum

Vacuum Filters
See Filters, Vacuum

Vacuum Pans
See Pans, Vacuum

Vacuum Pumps
See Pumps, Gas, Liquid or Vacuum

Valves and Cocks, Metal, Acid Proof
Chemical Pump & Valve Co., The
Cleveland Brass Mfg. Co.
Duriron Castings Co.
Lead Lined Iron Pipe Co.
Lunkenheimer Co., The
Pacific Foundry Co.
Pratt Eng. & Machine Co.
United Lined Tube & Valve Co.

Valves and Cocks, Stoneware, Acid Proof
General Ceramics Co.
Graham, C., Chem. Pot'y Wks.
Knight, Maurice A.
U. S. Stoneware Co.

Valves, Vacuum
Sarco Company, Inc.

Vanadium Alloys
Standard Alloys Co.

Vats, Metal, Acid Proof
Duriron Castings Co.

Vats, Stoneware, Acid Proof
See Stoneware Chemical

Vats, Wood
Caldwell, W. E., Co.
Eagle Tank Co.
Hauser-Stander Tank Co.
Pacific Tank & Pipe Co.
Redwood Manufacturers Company
Schwarzwalder, J., & Sons, Inc.
U. S. Wind Engine & Pump Co.

Viscosimeter
Bausch & Lomb Optical Co.

Wagon Loaders
Link-Belt Company

Waterproofing Compound (Liquid)
Anti-Hydro Waterproofing Co.

Water Tanks and Towers
See Tanks, Wood, and Tanks, Steel

Weighing Machinery
See Machinery, Weighing

Weighing Machinery, Automatic
See Machinery, Automatic Weighing

Welding and Cutting, Oxy-Acetylene
Prest-O-Lite Co.

Welding Materials
Acheson Graphite Co.
General Electric Co.
Goldschmidt Thermit Co.
International Oxygen Co.
National Carbon Co.
Prest-O-Lite Co., The

Welding Outfits, Arc
General Electric Co.
Lincoln Electric Co., The

Welding Thermit Process
Goldschmidt Thermit Co.

Wire Cloth
Multi-Metal-Separating Screen Co.
Newark Wire Cloth Co.

Wood Distillation
Apparatus for
Badger, E. B., & Sons Co.
Blair, Campbell & McLean, Ltd.
Devine Co., J. P.
Lummus, The W. E., Co.
Manitowoc Engineering Works
Zaremba Co.

Wood Pipe
See Pipe and Fittings, Wood

Wood Tanks
See Tanks, Wood

Zinc
Braun Corporation, The
Braun-Knecht-Heimann Co.
Metals Disintegrating Co.
New Jersey Zinc Company, The

Zinc Dust
Braun Corporation, The
Braun-Knecht-Heimann Co.
Merrill Metallurgical Co.
New Jersey Zinc Company, The

Zinc Oxide
New Jersey Zinc Company, The

Zinc Stripe
New Jersey Zinc Company, The

Zirconia
Foote Mineral Co.

ALPHABETICAL INDEX TO ADVERTISEMENTS